TANGANYIKA

DEPARTMENT OF AGRICULTURE

ANNUAL REPORT

1952

SECTION III

COMMONWEALTH MYCOLOGICAL INSTITUTE
10 AUG 1954

1954
PRINTED BY THE GOVERNMENT PRINTER
DAR ES SALAAM
Price Shs. 5/-

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ANNUAL REPORT

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SECTION III

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PROGRESS REPORT OF THE EMPIRE COTTON GROWING CORPORATION, UKIRIGURU, FOR THE SEASON 1951-52

COTTON, UKIRIGURU

Planting : 16th November to 4th January.
Picking : April to August.
Legal Uprooting Date : 7th September.
Rainfall for the period 1st October to 30th June : 52 inches.

Meteorology

The rainfall for the season exceeded anything experienced at Ukiriguru since recording started in October, 1931; the previous maximum for the period October to June was 47·63 inches (in 1946-47). The highest rainfall recorded for twenty-four hours was 2·62 inches (in March, 1938); in the present season 3·65 inches fell on the 8th November, 1951. Following 11·88 inches in November, in December there was rain on twenty-four days, totalling over 12 inches for the month.

There was a four-weeks' dry period in January–February. From February till the end of May rainfall was adequate and well-distributed.

Staff

Mr. J. M. Munro was on vacation leave from mid-June till early November. Mr. R. Smith left on transfer to Nyasaland on the 15th September. Mr. M. H. Arnold arrived on first appointment on the 4th September.

Mr. J. E. Peat attended the Namulonge Advisory Board Meetings in November, 1951 and November, 1952; he visited Southern Rhodesia at the request of the Cotton Research and Industry Board of Southern Rhodesia in December, 1951; and he attended the second meeting of the E.A.A.F.R.O. Specialist Committee on Plant Breeding in Kenya in September, 1952.

Ukiriguru Laboratories

The Ukiriguru Laboratories were opened on the 9th May, 1952, by the Member for Agriculture and Natural Resources, the Honourable A. E. Trotman. A message was read from His Excellency the Governor, Sir Edward Twining G.C.M.G., who very much regretted that he had been prevented by illness from being present at the opening.

GENERAL INTRODUCTION

The Lake Province cotton production for the 1951-52 season will be around 71,000 to 72,000 bales. There has been loss by fires at seed cotton stores; and in areas there was still some seed cotton on the plants when they were uprooted. This production is more than 20,000 bales greater than the previous record production in 1940-41, and 30,000 bales greater than the production of the previous two seasons. The cotton acreage is reported by the Regional Assistant Director of Agriculture, Mwanza, to be only about nine per cent

greater than in the 1950-51 season. With early rains much of the cotton was early planted; but, in areas, January-planted cotton, due to a dry January, germinated in February and was thus in effect late planted. The very heavy November-December rains flooded the lowlands, and from such lands little cotton was produced.

The Ukiriguru cotton yields are poorer than in many years. In contrast with this some of the yields around the Lake shore were very good indeed. Given sustained interest and continuing acreage, and given further cultural and seed improvement, still greater production should be possible, though there must be setbacks in some years.

Part of this season's increased production might reasonably be claimed for the improved seed stocks; there was no damage by jassid. Part of the yield increase is due to some improvement in planting technique, and early planting, largely through the activities of the departmental and Lake Province Cotton Committee staffs.

Of the twelve ginners operating in the Lake Province, this year seven are ginning around 7,000 bales each.

The season has been a difficult one for the food crops in the cotton growing areas. But it is essential to appreciate that the record cotton crop has not been produced at the expense of food production. Rather is it fortunate that the cash from the big cotton crop has allowed the purchase of food from more fortunate areas.

The very heavy November–December rains made cultivation in the heavy lands impossible, due to continuous flooding: important food crop planting there was not possible.

Great loss to bulrush millet and sorghum was suffered as a result of quite exceptional attacks of grain-eating weaver birds, the Diochs, *Quelea* spp. On Ukiriguru where probably more attention can be given to bird-scaring than by most African cultivators bulrush millet yields were miserable. Near the Ukiriguru hill (tree covered) yields were under fifty lb./acre, and in more open areas 120–300 lb./acre—at the worst a starvation yield, and at the very best a half crop. In spite of continuous bird-scaring the losses suffered by the Botanist on his sorghum lots were very heavy.

A third factor reducing food production was heavy stalk-borer loss in sorghum.

The tractor work of the Lake Province Cotton Committee has been held up, partly by difficulties in getting delivery of essential equipment—which equipment is now available for the 1952/53 season. Work on the heavy soils was at its most difficult in a season of exceptionally heavy rains. It is emphasized that this mechanization approach to peasant African agriculture is experimental; the lessons being learned are many.

1952-53 Cotton Planting

The early rains in the Lake Province have been very poor. At the time of writing little cotton has been planted and little food; though now with the onset of rain, land work is in full progress. Everything points to a reduced cotton acreage and to late planting. It is early to say what reduction in the cotton crop may have to be faced, but a reduction for this season would seem to be probable.

One important point that requires following up is a comparison of the results from late planting in years where the early rains have been poor, with the results from late planting in years where the early rains have been heavy—tied up with the leaching of accumulated soil nitrates by heavy early rains.

SUMMARY OF THE MAIN EXPERIMENTAL RESULTS

Three years' "tumbledown" fallow has again been shown to restore fertility better than a planted grass fallow; and to do so in the first cropping year.

Responses to three years under different resting crops are still evident six and eight years later.

Responses to organic manuring have fallen below the five per cent significance level in the eighth season after application, but this with the indicator crop millet, in a very difficult year for millet growing.

Nitrogen applied to cotton between January and March showed no difference in response to time of application. The effect of nitrogen was less in the presence of organic manure.

Tie-ridging may have depressed cotton yields slightly in comparison with ridges not tied in an exceptionally wet season.

Preliminary trials of cotton seed treatment against bacterial blight infection showed that a considerable degree of control was possible by this means. Stem lesion counts showed, however, that young seedlings from acid-treated seed were quickly infected where cotton had been grown the previous season, stressing the importance of trash-borne infection and its control by adequate rotation of crops. Two seasons under a grain crop seem to be the minimum period required to control trash infection.

Uk. 48 and Uk. 51 have yielded better than Uk. 46 in extensive trials throughout the Province.

By growing cotton during the dry season, a generation has been gained in the programme of crossing with Albar 51.

GENERAL ACCOUNT OF THE WORK FOR THE SEASON

Husbandry

Land Resting.—The residual effects of three years of Elephant Grass, *Cynodon*, *Hyparrhenia*, Pigeon Pea and Cassava are still apparent in the sixth and eighth years since the treatment residues were dug in. These trials were planted this season to bulrush millet; in all trials under this crop, plant weights were taken as a measure of yield, since much of the grain was taken by birds.

The comparative effects of three years of "tumbledown" and planted fallows in Trial (6) were discussed in last year's report (p. 49). These results are confirmed by Trial (5)—Table 1. Here again the "tumbledown" fallows were predominantly *Tridax repens*. In the first cropping year, these plots were outstanding in growth all through the season; the cassava plots which had a strong weed growth in the second and third years, were almost as good; planted grasses benefited the subsequent cotton crop, but the effect on millet was less marked. The effects of grazing and the inclusion of legumes in the planted grass mixture are still uncertain.

Trial (5) differs from Trial (6) in that the "tumbledown" fallow plots have done well in the first cropping year. The first year depression in yield in Trial (6)—1948-49—was attributed to competition from *Tridax*, self-sown from the fallow period; special attention was paid to weed control this season.

Manuring and Fertilizers.—The effects of organic manures applied in 1944-45 are still apparent in the eighth season after application. This experiment was planted with bulrush millet; the plant weights from the different treatments follow the same order as in previous years, but the differences are not significant. It was a bad year for bulrush millet. Ninth year responses, if any, are to be measured in 1952-53 with cotton as the indicator crop.

In Trial (9) yields were low, partly the result of insect damage to seedlings, and bacterial blight later in the season.

TABLE 1.—RESTING CROP TRIAL

Ukiriguru—Hill Sand—Trial (5)

Six blocks of fourteen plots (seven cotton, seven millet) of 1/35·6 acres. Five foot ridges, two rows at eighteen inches spacing, two plants per hole. Planted 13th–15th December, 1951. Cropping Rotation—two years cotton: two years millet.

First Cropping Year

Three years Resting Cycle 1948-49 to 1950-51	First Indicator Crops			
	Cotton		Millet	
Treatments	Yield seed Cotton lb. per acre		Yield Stalks and Heads lb. per acre	
Annual cropping, residues grazed	373		1,981	
Annual cropping, residues carried off	407	=100%	1,720	=100%
Cassava, weeded first year only	624	160	2,763	150
3 years "tumbledown" fallow—grazed	695	178	2,971	161
3 years planted grass fallow—grazed	575		2,111	
3 years planted grass fallow—not grazed	613	152	1,856	107
3 years planted grass fallow—undersown with *Tephrosia* and *Crotalaria*—grazed	630	162	2,265	123
Sign. Diff. (P.=·05)	122	31%	457	25%
S.E.	±42·3		±159	

The residual effects, Table 2, of both phosphate and organic manure are significant, with no obvious difference between forty-five and ninety pounds/acre of triple supers. Last season only the double rate of application was effective. The response to nitrogen is puzzling. Three replications were manured on 12th March, and the other three sixteen days later; the former showed no effect either in leaf colour or final yield, but the latter showed both, and the increase in yield was significant. There may have been an error in the first dressing, but this cannot be established.

Trial (23) was designed to discover the optimum time to apply nitrogen. Earlier trials with nitrogen applied to cotton at planting had given negligible responses; on the other hand, large responses had been obtained when nitrogen

was applied as a top-dressing about the time of flowering. Table 3 shows that in this season there was little difference between times of application ranging from January to March, but a slight falling off when applied as late as April. It was unfortunate that the trial could not be planted until the end of December, after two months of exceptionally heavy rain. The fact that there was a four weeks' dry period in January-February might explain the good response from the January application.

In both trials where nitrogen was applied, compared to the controls there was a suggestion of a depression in the first picking, but progressive increases in the subsequent pickings.

The response to organic manure in the absence of nitrogen was of the usual order, but there was no response to phosphate.

The super-raw phosphate applied on a large scale in two areas of the Province gave no striking results. The practical difficulty of organizing large-scale application on suitable soils, with control areas for comparison, is considerable. Delivery to the chosen areas was late owing to delays in lake and road transport, and the distribution was consequently rather hurried.

TABLE 2.—NPD EXPERIMENT

Ukiriguru—Hill Sand—Trial (9)

Main plots split to give 3 × 2 factorial, testing all combinations of:

(Main plots) n_0, n_1—0, 250 lb. sulphate of ammonia per acre.
(Split plots) d_0, d_1—0, 6 tons compost per acre.
p_0, p_1, p_2—0, 45, 90 lb. triple supers per acre.

Six replications of twelve plots, each 1/69·7 acres. Compost and phosphate applied 6th-8th December, 1950; nitrogen applied 19th-20th March, 1951, and 12th and 28th March, 1952. Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. Planted 12th November, 1951.

First Residual Year—Nitrogen Reapplied

Mean Yields — Seed Cotton lb. per acre.

	n_0	...	...	549	...	398	...	p_0	...	468	...	d_0	...	460
n_1	n_1	...	...	545	...	572	...	p_1	...	541	...	d_1	...	572
								p_2	...	537				
				(a)	...	(b)								
S.E.	...	...	...	±49·5						±19·3				±15·7

Interactions

	np_2	...	...	−28	...					p_2d −22	...	nd	...	−8
S.E.	...			±27·2						±27·2				±22·2

Treatment Yields.

	(1)		d		n		nd
p_0	...	344	...	466	...	453	...	652
p_1	...	476	...	539	...	570	...	608
p_2	...	448	...	556	...	530	...	660
				p and d treatments		...		±38·4
S.E.				n treatments		...		±85·6

(a) Nitrogen applied 12th March; Reps. I, III, IV.
(b) Nitrogen applied 28th March; Reps. II, III, IV.

TABLE 3.—ND EXPERIMENT

Ukiriguru—Hill Sand—Trial (23)

Four replications of 2×2 factorial, with split plots of 1/194 acres giving five nitrogen treatments. Compost and phosphate applied 17th-18th December 1951. Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. Planted 29th December, 1951.

p_0, p_1 —0, 90 lb. triple supers per acre.
d_0, d_1 —0, 6 tons, compost per acre.
n —250 lb. sulphate of ammonia per acre.

Year of Application

Mean Yields Seed cotton lb. per acre.

Main plots:	(1)	p	d	pd	S.E.
	1,044 ...	989 ...	1,184 ...	1,062 ...	±69·2
Interaction		pd. ...	—34		

Sub-plots: Time of application of nitrogen

Nil	Full rate 4 Jan.	Full rate 18 Mar.	Half rates 7 Feb. 18 Mar.	Half rates 18 Mar. 9 Apr.
825 ...	1,156 ...	1,144 ...	1,169 ...	1,059
Sign. Diff. (P=·05) ...		105	S.E. ...	±37·0

Interaction (n=mean of 4 treatments).
np ... +18 not significant.
nd ... —82 almost significant at P=·05.

	(1)	d
(1) ...	707 ...	945
n ...	1,095 ...	1,170

A further issue of superphosphate (forty per cent sol. P_2O_5) is being made in the coming season; sections will be left unmanured for comparison. Sulphate of ammonia, which was delivered too late for distribution in 1952, will also be issued (1) to those cultivators who were satisfied that the super-raw phosphate was effective; and (2) to some of those receiving superphosphate in the coming season.

Soil samples were taken from the areas where distribution has been or will be made. We are indebted to Dr. H. F. Birch of East African Agricultural and Forestry Research Organization for analyses of these samples, which show that while the percentage of base saturation is reasonably high, there is a deficiency of acid soluble phosphate. About these samples Dr. Birch writes:

> "Further support for the possibility of P response is given by the high sand low phosphate figures for the soils. Such soils are unlikely to contain much phosphate and are also unlikely adversely to effect by fixation the efficiency of the added phosphates. P responses may, therefore, be expected."

Four samples of soils from Ukiriguru were sent at the same time. These on analysis were similar to the samples taken elsewhere. Two were from the control plots of (6) and (8).

	Ex. Bases. m.e./100 g. soil							% Sat	
	Ca.	Mg.	Mn.	K.	Na.	Total	H.	B.E.C.	B.E.C.	pH.
Trial 8 Control	0·88	0·29	0·061	0·190	—	1·40	0·4	1·8	77·7	5·80
Trial 6 Control	0·67	0·70	0·024	0·313	—	1·70	0·6	2·3	73·9	6·20

	%C. Uncorr.	%N	C:N Ratio	Mechanical Analyses % Sand	% Silt	% Clay	% Organic Matter	Phosphates p.p.m. P_2O_5 Acid Sol. Ads	Acid Sol.	Ads
Trial 8 Control	0·20	0·020	13·5	87·2	8·1	4·3	0·4	40	6	2
Trial 6 Control	0·29	0·035	11·1	80·9	10·0	8·5	0·6	48	2	7

Ridging and Tying.—The cotton tie-ridged plots in the two Ukiriguru trials yielded slightly less than the untied plots; the differences were not significant. Cotton stalk weights were significantly reduced on the tied plots in the absence of compost, but not so when it was present.

At Lubaga, cotton yields were the same from tied and untied treatments. Another Lubaga trial planted with Dobbs sorghum showed a striking difference between flat and ridge cultivation; the yields were respectively 190 and 469 pounds/acre of grain.

Rotation.—The Ukiriguru rotation trial has now completed the first cycle of four years. Cotton has had little effect on the succeeding millet crops. But this season cotton, following two years of millet, yielded 140 pounds acre more seed cotton than any of the other rotations in the trial (Table 4); it is thought that this was due largely to a reduction in secondary bacterial blight infection, by rotation. If this is so, it would appear that at least two seasons under grain are required to reduce the trash infection carry-over.

TABLE 4.—ROTATION TRIAL

Ukiriguru—Hill Sand—Trial (19)

Six blocks of eight plots, each 1 48·4 acres. Five-foot ridges, two rows at eighteen inches spacing, two plants per hole. Cotton planted 13th November 1951; bulrush millet planted 21st January, 1952.

Fourth Year of Trial

C=Cotton M=Bulrush Millet

Rotation	Seed Cotton lb. per acre		Rotation	Millet Stalks and Heads lb. per acre
C: C: C: C:	412=100%		M: M: M: M:	1,775
M: C: M: C:	448	109	C: M: C: M:	1,695
C: M: M: C:	588	143	M: C: C: M:	1,800
M: M: C: C:	424	103	C: C: M: M:	1,720
Sign. Diff. (P=·05) ...	110	27%		Not Significant.
S.E.	±36·6			±112

In a similar rotation trial at Lubaga, now in its third year, where sorghum replaces millet as the grain crop, there is no evidence that sorghum reduces the growth and yield of the following cotton crop; as, from observation, occurs on the Ukiriguru hill sands.

A year of clean weeded fallow at Lubaga on "ibushi" black loam has resulted in a lower yield of cotton in the following season. This is the first trial of this treatment, and the effects of "tumbledown" fallow are now under test there.

COTTON BREEDING

Uk. 48 was multiplied in the Buchosa area of the Geita District. Uk. 51 was multiplied on just over 100 acres in Kome Island in the Geita District. Apart from mixed areas, predominantly Uk. 48 bordering the pure Uk. 48, the remainder of the Province was growing Uk. 46. This 1952-53 season Uk. 51 will cover almost all Kome Island. Pure Uk. 48, plus Uk. 48 with some admixture of Uk. 46, will cover nearly half the Province; the remainder will be under Uk. 46.

The responses from Uk. 46, Uk. 48 and Uk. 51 compared to the replaced Mz. 561, from trials at Ukiriguru, Lubaga and district plots are given in Tables 5 and 6. The increased yielding of the new issues is considered very satisfactory; and what is particularly pleasing is the general consistency of the yield increases over a wide range of conditions. A further yield increase in the Provincial cropping, due to strain, may be anticipated when Uk. 48 reaches general cultivation. Uk. 48 cropping has been well reported on in the Nyanza Province in Kenya, and at Nachingwea in the Southern Province of Tanganyika.

The ginning percentage, for Mz. 561, accepted for the ginning formula, has been 30·75 per cent. For Uk. 46 it is 32·0 per cent. Standard Bale tests for Uk. 46, and Uk. 46-Uk. 48 Mixed, give a mean ginning percentage figure for all Provincial ginneries of 32·55 per cent for commercial ginning, with 2·03 per cent dirt, or 33·22 per cent ex opener (figures from Mr. E. Drakley, B.C.G.A. Agricultural Officer, and Ginnery Inspector). 1·8 per cent on 30·75 per cent equals a lint increase of 5·8 per cent. Ginning percentage variations were recorded from ginning area to ginning area.

Uk. 51 was grown on Kome Island by eighty-two growers, under the guidance of Mr. C. Decker, Agricultural Assistant, Nyamahona. Seed for planting was sparingly used. The mean yield per acre was 850 pounds/acre. There were yields of around 1,500 pounds/acre, the best was just short of 2,000 pounds/acre; the poorest 100-200 pounds/acre. Uk. 51 would seem a reasonable replacement to Uk. 48 in the system of wave seed replacement. It has probably slightly better jassid resistance than Uk. 48 -itself good—is possibly slightly heavier cropping, and may have slightly better spinning qualities.

Again, we are very much indebted to the Shirley Institute for tests on fibre characters, spinning test reports, and reports on yarn appearance. Without such information the plant breeder's assessment of quality is dangerously incomplete. It is proposed to send to the Shirley Institute a wide range of 1952 season lint, from district plots as well as from Ukiriguru, for quality assessment.

It is proposed to issue a Uk. 53 for the 1953-54 season. The yield trial results of "possible" strains are shown in Tables 5 and 6. Some of the strains are very good in the field, but critical spinning assessments are now necessary.

The spinning reports on Mz. 561, Uk. 46 and Uk. 48 continue to show them as having the same general spinning qualities and yarn appearance. It may be that Uk. 51 will be slightly better -the seed cotton from the first multiplication was reported on favourably—but reports on the range of spinning tests have to be awaited.

TABLE 5

Yield Results—1952 Strain Trials

	Ukiriguru Hill Trial			Ukiriguru "Mbuga" Trial			Lubaga "Ibushi" Trial			Ukiriguru (Nyashimba) Trials. (Exhausted soil)								Ukiriguru Njihiji Trial		
	Yield seed cotton lb. per acre	Ginning %	Lint % of Uk 46	Yield seed cotton lb. per acre	Ginning %	Lint % of Uk.46	Yield seed cotton lb. per acre	Ginning %	Lint % of Uk.46	Yield seed cotton lb. per acre				Ginning %	Lint % of Uk. 46				Yield seed cotton lb. per acre	Ginning %	Lint % of Uk.46
										A	B	C	D		A	B	C	D			
Mz.561	656	33·5	87	387	32·5	93	894	35·0	73	240	286	239	268	32·4	75	100	81	84	789	32·8	82
Uk.46	710	35·5	100	386	35·0	100	1,210	35·6	100	293	275	275	293	34·8	100	100	100	100	901	35·0	100
Uk.48	804	35·7	114	431	35·3	113	1,315	36·0	110	326	405	275	373	35·4	111	153	103	127	836	36·5	97
Uk.51	859	35·2	120	443	35·3	116	1,474	35·0	120	319	427	333	474	34·3	108	154	120	154	916	36·8	107
ex 5/57																					
7/7*	684	36·5	99	421	36·0	113	1,170	36·0	98												
7/9*	779	36·5	113	429	35·5	113	1,201	35·5	99												
7/14	773	36·8	113	325	36·8	107	1,152	37·5	100												
9/10	766	37·2	113	428	37·3	119	1,266	37·5	110	315†				36·3†	111†						
9/16	856	37·8	129	441	35·8	117	1,241	37·8	109	340†				36·3†	117†						
ex 3/28																					
7/150*	768	35·8	109	389	35·0	101	1,120	36·3	94		373‡			35·7‡		140‡					
ex 7/150																					
9/102	766	36·5	111	367	36·0	98	1,091	36·3	92												
9/107	754	36·5	109	374	35·5	99	1,212	36·3	102												
ex 6/318																					
8/95	849	36·5	123	460	36·3	124	1,165	37·0	100												
8/151	866	35·0	120	—	—	—	1,077	37·0	92												
ex 6/320																					
7/278*	875	35·2	122	457	35·5	120	1,230	37·3	108			451§		34·2§			164§				
8/290*	896	34·5	123	510	33·5	127	1,354	35·0	110												
ex 6/322																					
8/341*	839	34·5	115	396	35·0	103	1,133	36·0	95												
ex 4/86																					
9/117	756	39·0	117	393	38·0	110	1,245	38·8	112												
Least Sign. Diff. (P = ·05)	107		16	60		16	191		16	75	84	89	85		26	33	33	30	222		25
Std. Error	±38			±22			±69			±27	±30	±32	±30						±79		
% Grade "C"		27			27			52						36						20	
Details of Trials Design Plot size	7×7 balanced lattice 50×5 feet			7×7 balanced lattice 50×6 feet			7×7 balanced lattice 64×4 feet			5×5 balanced lattices. 25×5 feet.									5×5 balanced lattice. 25×5 feet.		
Planting Date Spacing.	19th November, 1951 5 ft. ridges, 18 in. spacing. 2 plants per hole.			16th November, 1951 3 foot rows, 18 in. spacing. 1 plant per hole.			12th December, 1951 4 foot ridges, 18 in. spacing. 2 plants per hole.			28th November, 1951. 5 foot ridges, 18 in. spacing, 2 plants per hole.									29th December, 1951. 5 foot ridges, 18 in. spacing. 2 plants per hole.		

*Component strains of Uk.51. †Best 1950 selections from 9/10 and 9/16 respectively. ‡Mean of the two best 1950 selections from 7/150. §Mean of the four best 1950 selections from 8·290.

TABLE 6

DISTRICT PLOTS 1952—YIELDS OF LINT % UK. 46

District	Geita		Mwanza (Nassa)		Ukerewe		Kwimba		Maswa		Shinyanga	
	Ibondo	Arugongo	Sligala	Bukabile	Buhima	Bulamba	Mwanangwa	Kitunga	Lulago	Somanda	Lagana	Butulwa
Mz. 561	98	99	99	78	99	74	83	84	73	83	81	80
Uk. 46	100	100	100	100	100	100	100	100	100	100	100	100
Uk. 48	115	134	105	106	121	101	121	118	110	109	113	114
Uk. 51	98	122	116	102	120	105	109	121	120	100	133	113
ex 5/57												
7/7*	103	122	109	92	93	91	107	97	115	107	104	116
7/9*	98	123	114	94	101	106	105	116	118	116	114	131
7/14	109	134	117	99	97	106	94	109	117	115	126	122
9/10	98	123	105	100	114	106	115	117	136	129	108	122
ex 3/28												
7/150*	105	111	81	85	103	88	106	89	108	92	76	112
ex 7/150												
9/102	112	111	83	82	94	96	96	108	100	95	94	91
9/107	101	101	92	92	93	87	109	98	103	106	102	90
ex 6/318												
8/95	104	140	113	117	121	99	100	130	132	128	115	124
ex 6/320												
7/278*	136	144	102	117	119	114	104	106	110	99	105	129
8/290*	126	161	101	102	121	100	114	156	138	105	119	119
ex 6/322												
8/341*	103	123	111	86	121	93	96	108	111	100	96	120
ex 4/86												
9/117	85	129	114	110	89	96	114	111	114	126	121	124
L.S.D. (P=·05) ...	16	20	22	17	15	N.S.	16	20	19	16	24	25
Yield Uk. 46 Seed Cotton lb. per acre	689	1,234	1,061	1,093	571	1,282	1,109	562	787	1,168	1,521	864
S.E. (lb. per acre)	±38	±82	±82	±66	±30	±114	±62	±38	±52	±64	±123	±74
%Grade "C" ...	7·2	8·5	10·7	27·6	6·0	8·0	33·5	48·0	33·8	15·3	13·7	37·5

Details of Trials:

Design 5 × 5 quadruple lattices. Plot size: All plots except Butulwa: 5 feet (one ridge) × 50 feet. Butulwa: 4½ feet (one ridge) × 50 feet.

*Component strains of Uk. 51

Ukiriguru strain trial yields were poorer than most years, especially in the valley-bottom "mbuga" trial. There was American bollworm loss and heavy bacterial blight loss. The run of district plot yields is high. One district plot on alluvial land was a failure, and one also on heavy land a partial failure; Uk. 46 (control) in seven out of the remaining twelve trials yielded over 1,000 pounds/acre.

The emphasis in the immediate breeding work has been switched from further selection within the segregating "Local" strains, to the crossing programme for resistance to bacterial blight; crossing the best of the Ukiriguru strains with selections from Dr. Hutchinson's Albar 51. Better leaf hair (jassid resistance) is also being crossed on to outstanding Ukiriguru lots which are not up to standard for leaf hair.

A start to the crossing programme, with the Albar 51 lots, was made, in-season, 1952, and continued out-of-season 1952, the plants being hand-watered. More material than can be carried to a finish is included in the first programme, but it is hoped that considerable discarding will be possible as stocks can be faulted.

The Albar 51 lots are so incomparably better than Albar 49, that the crosses where Albar 49 had been used have been discarded.

Pests.—As a generalization for the Province, pest damage was not heavy.

At Ukiriguru there was quite serious American bollworm loss from the end of February. There was also appreciable Spiny bollworm loss. Stainers, mainly *D. fasciatus*, at the end of the season were more numerous than in most years. There was an exceptionally high percentage of Grade C for Ukiriguru—around thirty per cent. A considerable amount of staining, however, must have been caused by bacterial boll-rot.

Specimens of Pink bollworm were found at Ukiriguru at the end of May, more than in any year previously. It was feared that there might be a Pink bollworm attack on the out-of-season crossing plot, but this did not happen. (But on this plot from the beginning of November onwards there has been a steady inwards migration of *D. superstitiosus*).

Pink bollworm has been reported from mainland areas near the Lake, and considerable numbers were reported in June in Western Ukerewe Island.

It is hoped, with the distribution of Uk. 46 and the following-up of Uk. 48 and Uk. 51, that jassid will now no longer be a major factor liable to affect the Lake Province crop. The position will be the more secure when Uk. 48 covers the whole Province. At Ukiriguru, even on the "local" interlards in the strain trials, there was little jassid damage, though a line of Stoneville 20 was blasted by jassid attack.

Along the bush edge in South-West Geita, over a considerable area, there was a blasting attack of *Helopeltis* spp. In the area affected great loss of crop was suffered.

At Nachingwea in the Southern Province, in the O.F.C. area, Red bollworm larvæ (*Diparopsis castanea*) were reported at the end of May, from the small area of cotton growing there.

Bacterial Blight (*Xanthomonas malvacearum*).—During the 1951/52 season, bacterial blight was widespread in the Province and was especially severe where the crop was grown on poor soils, and where cotton had been grown in successive seasons on the same land.

At Ukiriguru, the disease was much more severe than has previously been experienced, climatic conditions being favourable for its spread. In the past, acid delinting of seed has apparently provided effective control of seed-borne infection. With the absence of a build-up of trash as a secondary source of infection, a condition which obtained whilst the station was developing and new land was continually being opened up, this control by acid treating has generally been sufficient.

This season, cotton bulks sown with acid treated seed showed fewer stem lesions on the young plants than neighbouring bulks sown with untreated seed; but high lesion counts were found even where seed had been acid treated, on land continuously planted to cotton. A break of one or two years under millet seemed to give some control (Ref. Table 4).

During a survey of the phosphate distribution area on Ukerewe Island the effect of crop rotation was very striking. Cotton following cassava or fallow was much more vigorous and freer from bacterial blight than on land which had been carrying cotton for a number of seasons.

In view of the increasing interest in seed-borne infection, a trial involving eleven seed treatments was laid down. A comparison of the treated plots with the controls showed a marked reduction in cotyledon lesions. The percentage of infected seedlings in the treated plots was from four to nineteen as against fifty-three per cent natural infection in the controls.

The differences between individual treatments were not statistically significant. The indications were, however, that acid delinting and treatment with mercurial dusts were more effective than copper dusts. This agrees with results in Uganda, the Sudan, and French Equatorial Africa. From seed which had been infected with bacterial suspension, the control plot showed ninety-six per cent seedling infection whilst plots treated with mercurial dusts showed three per cent and four per cent infection, as against eight per cent and fifteen per cent in those treated with copper dusts (Samples of Y.F. 2776 and Agrosan GN5 used in this experiment were kindly provided free of charge by Plant Protection Limited).

Both seed-borne and trash-borne infection are thus important under Lake Province conditions; the one can be controlled by seed dusting, the other by rotation. It would be unwise to expect effective control from seed-dusting alone.

Largely as a result of the success achieved in Uganda, the introduction of seed dusting on a commercial scale is proceeding rapidly in the Province. Acting for the Lake Province Cotton Committee, the Regional Assistant Director of Agriculture, Mwanza (by arrangement with Mr. Jameson, Senior Research Officer, Kawanda) sent 200 tons of Uk. 48 seed to the Uganda Co., Kampala, for Perenox treatment. This is being planted in hill sand areas, on land which has not recently carried cotton. The resultant crops should form an interesting comparison with those grown from untreated seed.

The Lake Province Cotton Committee proposes to install one Booth Drum Mixer for the 1953-54 season, and orders for mixers are being placed independently by Lake Province ginners.

Work on breeding varieties resistant to bacterial blight is continuing. Hybrid seed for planting in the coming season is being treated with *Xanthomonas* inoculum and will be planted on land which has borne heavily infected crops in the past. The segregating progenies will be inoculated, using Dr. Wickens' needle-prick technique.

Wilt Disease.—A wilt disease with symptoms similar to those of *Verticillium* wilt occurred in the cotton variety trial at Lubaga. Subsequently other affected plants were discovered in nearby native shambas, chiefly in late planted cotton. At Lubaga the wilt seemed to die out towards the end of the season. Identification of the pathogen has not yet been possible.

J. E. Peat.
J. M. Munro.
M. H. Arnold.

APPENDIX

Origin and Special Characteristics of the Main Cotton Strains Mentioned

Lake Province ...	"Local." The commercial cotton in the Province prior to the issue of Mz. 561—mainly of Uganda local origin.
Mz. 561	A straight selection from "local" first multiplied in the 1946-47 season
Uk. 48	A seed issue made up of four strains, of better jassid resistance than Uk. 46. It was issued for the 1948-49 season.
Uk. 51	A seed issue made up of seven strains, with jassid resistance; first issued for the 1951-52 season.
3/28	Ex Mz. 561.
4/86	Ex 1/45, ex Mz. 561; a constituent of Uk. 46.
5/57	A derivative of 3/17, itself a straight selection from "Local".
6/318...	Ex 4/35, itself a derivative of Mz. 561.
6/320, 6/322	Ex 4/35, cousin strains of 6/318.
7/150...	Ex 3/28; high jassid resistance.
"Albar" 49, "Albar" 51 ...	General terms for 1949 and 1951 selections from Nigerian Allen, highly resistant to bacterial blight; ex Dr. J. B. Hutchinson.
Stoneville 20 ...	An American variety resistant to bacterial blight; ex Namulonge.

EMPIRE COTTON GROWING CORPORATION—EASTERN PROVINCE PROGRESS REPORT, 1952

Planting Period: Mid February to mid April.
Picking: July to October.
Uprooting: By 31st October.
Rainfall: January to June: 28·5 inches.

INTRODUCTION

The report covers the work on Ilonga Experiment Station, Kilosa and on four district plots.

Meteorology and Season

Good rains fell in February and it was possible to establish nearly all the maize fields on the station early in that month. The cotton was planted early in March, and was established under favourable circumstances but very heavy insect attack particularly by American bollworm *Heliothis armigera* developed early in the season greatly reducing yields; this is referred to in more detail later.

Cotton Breeding

A collection of one hundred and eighteen selections from the previous season was carried forward. This contains a number of types of a heavy yielding nature and with improved lint. A number of strains in small bulk form were also carried forward.

The yields over all these strains were very much influenced by insect attack, which tended to mask differences in yield. Dusting with ten per cent DDT and three per cent Gamma BHC was resorted to over the whole station in order to ensure the production of some crop.

A large area on the station was planted with the strain 47/10 which it is proposed to bulk up for distribution in place of the present local seed in use. A spinning test and report on 47/10 and other strains was carried out by the Shirley Institute. This showed that the yarns from 47/10 were the strongest but the appearance of yarns in the higher counts 50's and 64's was only fair. It also indicated that 47/10 lint is considerably longer than Local.

A ginning test carried out at Kilosa Ginnery on about one ton of 47/10 seed cotton showed a figure of 29·7 per cent which is about 0·7 per cent lower than that for Local.

Insect Pests

Insects, and in particular American bollworm *Heliothis armigera*, were the dominating factor this season where the cotton crop was concerned.

The work on these pests was divided in the following ways (a) Routine recording of all pests on the cotton on the station and on the four district plots; (b) a certain amount of work in the insectary on larval instar and pupation periods of *Heliothis*; (c) routine recording on the incidence of *Heliothis* and *Dysdercus* spp. on hosts other than cotton; (d) a trial of insecticide mixtures applied in various ways.

The routine records showed a similar trend to that in previous seasons except that the attack of *Heliothis* was the most severe ever experienced on Ilonga. The attack on the district plots was also heavy. Stainers (*Dysdercus* spp.) were present in negligible numbers and the proportion of stained lint was very low.

American Bollworm—Heliothis Armigera

Larvæ were found in moderate numbers during January on native maize planted in October and November, 1951. They were recorded until April by which time most of the maize crops had failed owing to poor rains.

On the station the main maize crop was planted in February and a large population built up on this during March and April, reaching a peak at the end of April but persisting in some numbers on the later planted maize into May and June. At the same time larvæ were recorded for the first time on dwarf sorghums planted at Ilonga.

The attack of *Heliothis* on cotton resulting from the breeding up on these crops commenced early in April on March-planted cotton three weeks before flowering began. The population then was only of the order of 140 larvæ per acre but egg-laying was at the rate of 1,360 per acre. Flowering commenced on 5th May, delayed to some extent by this early attack. The population increased rapidly and by 29th May had reached a peak of 28,550 per acre in the control plots of the insecticide trial, while at the same time it had reached 44,000 per acre in the routine recording cotton plots near by. This resulted in the loss of practically all squares and bolls and the larvæ were reduced to eating leaves. Sixth instar larvæ were found dead at this time and the population steadily declined until the larvæ disappeared in the middle of August.

As a result of this attack practically no crop was obtained from any of the cotton on the station which was not treated with insecticide. Attack of *Heliothis* developed on all four district plots but none were of the same intensity as that on Ilonga. They did however cause very considerable loss of crop which has very much hindered the bulking up of the strain 47/10 to which all these plots were planted.

Spiny Bollworm—Earias Spp.

This appeared in some numbers at the beginning of May and built up to a peak of some 6,000 per acre by the middle of June, contributing to the loss caused by *Heliothis*.

Pink Bollworm—Platyedra Gossypiella

Larvæ were recorded throughout the season in small numbers but nowhere could it be said to be serious.

Stainers—Dysdercus Spp.

Probably owing to the extent of the damage caused by *Heliothis* the influx into the cotton was very small early in the season and not until August was any considerable population recorded. *D. intermedius* and *D. fasciatus* then appeared and breeding took place in the open bolls.

Calidea Dregei

This was only recorded in small numbers in cotton. At Ilonga a large population of adults appeared on dwarf sorghums in April and a certain amount of breeding took place. It was thought that there would be migration into the nearby cotton as the sorghum ripened off and accordingly handpicking of the area was carried out. On 22nd April 2,509, adults, six first instar nymphs and eleven egg batches were collected from just over an acre. A week later a second collection of 1,168 adults was made with batches of first to fourth instar nymphs and ninety-three egg batches.

A large population also developed on a collection of Hibiscus species planted on the station. No increase in numbers of *Calidea* in the cotton was recorded when these became unattractive. It is not known where the influx came from or to what host they went.

Helopeltis Bergrothi

Rather more damage due to this pest was recorded this season which could, in the case of the native gardens, be correlated with an increase in the amount of castor (*Ricinus communis*) planted.

Jassid—Empoasca Fascialis

This was of no importance.

Lygus Vosseleri

A small amount of damage was caused by this pest to some cotton planted near to dwarf sorghum where a certain amount of breeding had taken place.

Aphis Gossypii

Some damage was caused in plots where only DDT was applied as an insecticide due to the killing off of the *Coccinellids* and *Syrphids*.

Insecticide Trial

The main aim of this trial was to confirm the results obtained in 1950 and 1951. These had shown that a very considerable degree of control of American bollworm *Heliothis armigera* and a certain degree of control of Spiny bollworm *Earias* spp. could be obtained by the use of a dust containing ten per cent DDT and an aphicide in the form of three per cent Gamma isomer Benzene hexachloride mixed in talc. The dust had been applied by rotary hand dusters at a rate of sixteen pounds per acre.

The trial was also designed to show whether more accurate timing would give better results at the same time. Three different methods of timing were used. The amount of aphicide included was also varied in an attempt to reduce cost.

The trial was laid out in the following way. Plots of 1/10 acre in size were laid out in randomized block form with a border of eighteen feet of giant sorghum between each. The sorghum was intended to check drift of dust from plot to plot, and had previously proved very effective. The trial was planted with the strain 47/10 at a spacing of 3 ft. $\times$ 3 ft. with two plants per hill. There were seven replications which with six treatments and controls gave forty-nine plots in all.

The treatments were:—

3A—10% DDT plus 3% Gamma BHC, first application at the point when the bollworm larvæ population reached 1,000 per acre.
3S—Similar dust first application when "flared" squares reached 1,000 per acre.
3F—Similar dust first application when flowering reached 1,000 flowers per acre.

Three further treatments were 1A, 1S and 1F, the dust being applied at the same times but the amount of gamma BHC being reduced to one per cent.

The dust was applied by rotary hand guns at ten-day intervals at a rate of approximately sixteen pounds per acre. The ten per cent DDT plus one per cent Gamma BHC plots were dusted five times and the ten per cent DDT plus three per cent Gamma BHC six times except in three blocks which were dusted seven times.

The cotton was planted on the 12th March and bollworm recording commenced on the 12th April when 140 larvæ per acre were recorded together with 1,360 eggs per acre. A second count on the 19th April showed 235 larvæ with 1,785 eggs per acre. Counts were thereafter made at three-day intervals and nine days later the population had reached 1,080 per acre.

Accordingly the plots laid down to test this particular timing were dusted on the 29th April, the "flared" squares plots reached a 1,000 per acre two days later and were dusted on 3rd May three days after the first timing.

The flowering plots did not reach a 1,000 per acre until eight days later and were dusted on the 10th May.

The dusting dates over the whole trial are given in the following Table I.

TABLE I

No. Dustings	Bollworm Plots (A)	Flared Squares (S)	Flowers (F)
1.	29.IV	2.V	10.V
2.	9.V	12.V	20.V
3.	19.V	22.V	30.V
4.	29.V	1.VI	9.VI
5.	8.VI	11.VI	19.VI
6.	20.VI 3A plots only	21.VI 3S plots only	29.VI 3F plots only
7.	28.VI 3A plots only in 3 blocks	1.VII 3S plots only in 3 blocks	

RECORDING

Insect records were taken in the control plots and the figures for bollworm incidence were recorded.

A continuous record of the progress of the crop was carried out in the following way. As soon as the plants started to set squares and as soon as the squares could bear the weight they were ticketed with the date. This was carried out daily on five plant hills in each plot. The number of squares so set was recorded. All shed squares, bells and flowers were collected and the proximate cause of their shedding diagnozed in so far as possible. Mature bolls were picked and examined locule by locule for their condition.

These were divided into:

(a) Completely rotted due to bollworm.
(b) Grade III due to bollworm.
(c) Completely rotted due to stainer.
(d) Grade III due to stainer.
(e) Grade I.

The figures so obtained give a picture of how the crop was set and when, and the fate of the crop set in any particular week. The setting week by week over the whole experiment together with the shedding of squares and bolls according to when they were set were recorded.

There was early development of attack by *Heliothis* and a very rapid rise in population after the beginning of May up to a peak of over 28,000 larvæ of this species by the middle of that month. There was also an increase in *Earias* which took place during June up to a peak of 5,700/acre which assisted in destroying the setting taking place at the end of that month.

The peak of shedding did not coincide with the bollworm peak as the extraordinarily high population of larvæ in both the control and treated plots reduced setting very rapidly with consequently less crop present to be shed.

No further setting of any real importance took place after the end of June even in the plots which received two further dustings.

While the yield figures for a straight comparison between similar times of application of the two mixtures cannot be made owing to differing numbers of applications, the analysis for all treatments shows that the mixture containing three per cent Gamma BHC gives a better result. The reason for this is not yet clear.

The figures resulting from the analysis of bolls were recorded both for the control plots and the "flared" square plots treated with ten per cent DDT plus three per cent Gamma BHC. There was a great difference between the number of bolls left on the plants and much subsidiary damage done to the grade of these bolls.

The yield figures which can be compared are given below:—

Dust applied five times

Treatment	1A	1S	1F	C
Yield per acre lb. seed cotton	839	913·5	938	13

The differences between the treated plots are not significant at the five per cent level.

TABLE 2

Dust applied six times

Treatment	3A	3S	3F	C
Yield per acre lb. seed cotton	1,365	1,566	1,344	13

3S is significantly better at the five per cent level than the other two treatments.

These figures are very striking confirmation of the previous results particularly when yields of the above order were obtained in the face of an attack of this size. In 1951 the peak of *Heliothis* attack was only 7,000 per acre as compared with over 28,000 this season.

The treatment timed on "flared" squares would appear to be the best on the basis of records. It is thought however that a timing on 1,000 flowers per acre would probably be the best from the point of view of practical application.

Spraying Trial

A low volume spraying trial was carried out by Pest Control Limited using their Weedmaster sprayer mounted on a Ferguson tractor.

The treatments tried were:—

A	0·5 lb. DDT per acre	5 gallons per acre applied 5 times at 7-day intervals.
B	1·0 lb. DDT per acre	
D	1·67 lb. DDT per acre	
E	0·5 lb. DDT per acre	5 gallons per acre applied 5 times at 10-day intervals.
F	1·0 lb. DDT per acre	
G	1·67 lb. DDT per acre	

The first application was at the 10th May. Some control of bollworm was obtained, particularly with 1·67 pounds DDT per acre applied at seven-day intervals, but not to nearly the same extent as in the dust experiment described above. This was partly due to the fact that the machine did not distribute the spray adequately owing to being mounted too low and partly to the fact that DDT was used alone allowing of a building up of Aphis which affected the setting of crop by the plants.

A. G. Bebbington,
Senior Scientific Officer,
Empire Cotton Growing Corporation
and
H. J. de S. Disney,
Entomologist,
Empire Cotton Growing Corporation

Note:—The original report was illustrated by figures.

THE ILONGA AGRICULTURAL STATION, ANNUAL REPORT FOR THE 1951-52 SEASON

Meteorology

The short rains in 1951 started early and were particularly heavy, 19 inches falling from 25th October to 31st December, 13·3 inches falling in November. There was a dry period of three weeks from 18th January. The main rains started on 6th February, were marked by two drought periods of ten days each, and stopped early, no useful rain falling after 6th May, with the exception of 0·73 inches in June. A total of 47·63 inches fell from 1st October to 30th September, 1952. The rains during March and April in Kilosa District were very unevenly distributed and most maize crops were partial or complete failures. In this respect the station was fortunate as while the main rain was below normal, it was well distributed.

Development

Building.—Two country cottage type houses were completed.

The office and laboratory blocks, built of Arcon roofing and cement blocks, were built, as well as an insectary and a small dispensary.

At the end of the year a start was made with four temporary Arcon houses for members of the Colonial Insecticide Research Unit, who are to be based at Ilonga.

Clearing

Twenty acres of heavy bush were cleared by hand and machinery. A small addition was made to Block D.

In order to reduce labour requirements and to improve agricultural operations the station has been further mechanized. A new TD 9 International tractor and Massey-Harris 744 D row-crop tractor have been bought, together with a 606 John Deere plough, 8′ 6″ Baronet disc harrow, Massey-Harris ridger cultivator and maize planter. In addition certain items of equipment have been loaned to the station for trial from Kilangali surplus equipment. This includes D8 Caterpillar tractor and Davis plough for clearing and preliminary preparation of new land.

Policy

A programme was drawn up early in 1952 to broaden the work at Ilonga. It is intended that, in addition to the selection and first bulking of improved cotton strains, Ilonga should become a centre for the improvement and bulking of maize and sorghum suitable to Eastern Province conditions, the observation and bulking of suitable virus resistant cassava strains, and investigation of minor crops, including soya bean. In addition, agronomic trials covering tillage, rotations, weed control and mechanization of crops suitable for Non-Native agriculture will be undertaken. A gradual extension of cleared land is also planned.

Cotton

A detailed account of cotton work is included in the Eastern Province Progress Report of the Empire Cotton Growing Corporation which precedes this report.

Field yields of cotton which had been dusted ranged between 400 pounds to 700 pounds seed cotton per acre. The grade was generally good.

The success of dusting cotton with ten per cent DDT plus three per cent Gamma BHC mixture in talc raises the question of practical application of this treatment on a field scale. The next stage would seem to be demonstration in native areas, while studying the problem of applying the knowledge practically to the large number of small scattered plots of the African cultivators. For this purpose an improved hand dust gun is required. It is also necessary to investigate suitable machines for use at Ilonga and on Non-Native estates, should Non-Native cotton production begin again on any scale.

Other Crops

Maize.—A start was made with Harland's method of improvement, using Eksteen maize.

Approximately 200 single plant crosses were made, which will be tested in ear-rows.

Bulk plantings of Katumbili maize cropped satisfactorily giving an overall yield of seven and a half bags per acre from 100 acres.

There was a heavy incidence of maize rust, believed to have been *Puccinia polysora*. This rust was recorded from elsewhere in the District this season.

Sorghum.—A start was made with a sorghum collection, particularly of dwarf and semi-dwarf types. Of forty-three varieties under observation the following appeared most promising:—

Dobbs,
Enyanza,
Early Shallu,
Oklahoma.

There was some bird damage in dwarf white-grained varieties.

Cassava.—Twenty-one Amani hybrids were further bulked to produce planting material for a variety trial. So far no signs of mosaic have developed.

Soya Bean.—Four varieties were obtained from Overseas Food Corporation, Kongwa, for observation. The plots were sown late and yields were low owing to poor filling of the pods.

Hibiscus.—Forty varieties were sown for observation. The most promising were *Hibiscus cannabinus* ex Egypt and a Java strain. Several varieties showed too much branching, and some a procumbent habit. Fibre was produced from the most promising for trial in the United Kingdom.

Lucerne and Kudzu.—Small observation plots were sown in February. They have survived a long dry season, but growth of the lucerne has never been vigorous.

General

There has been a big demand for Katumbili maize seed by Non-Native planters and Africans, and 380 bags of selected and unselected seed have been sold.

The total receipts from the sale of produce ex Ilonga during 1952 were 29,000/-, while maize produced on the farm and held for posho was valued at 20,400/-.

N. R. Fuggles-Couchman,
Agricultural Officer,
Ilonga, Kilosa

COFFEE RESEARCH STATION, LYAMUNGU, MOSHI, ANNUAL REPORT FOR 1952

Weather Conditions

The short rains of 1951 were heavier than usual and carried on well into January, 1952. 15·94 inches of rain fell in the last quarter of 1951 and a further 3·63 inches in January. This prolonged rain had a very marked effect on the coffee crop of 1952 because it induced excessive vegetative growth, this reducing the carbohydrate reserves of the trees to a level which did not allow of the appearance of flower buds in quantity. In some parts this was the main factor in the small crop of twenty tons of parchment coffee in the 1952 season, but in other parts the very heavy crop borne in 1951 together with the shortage of labour for adequate weeding, were contributory factors.

The weather in 1952 has been exceptionally dry, only 44·61 inches of rain having been recorded. April and May were much drier than usual, only 11·66 inches and 12·65 inches of rain having fallen. The long rains started late and tailed off early and the weather became warm a good deal earlier than usual, with the result that the crop started to ripen as early as the end of May. Picking finished before Christmas. The short rains practically failed, being only 4·00 inches in the last quarter of the year, and sufficient to produce two flowerings but very little set.

Off-Station Experiments

Four new clonal selection trials off-station using single tree plots for the first time, were planted at the following centres:—

1. Mwika (E. Kilimanjaro) Moshi Native Coffee Board.
2. Mbosho (S. Kilimanjaro) Moshi Native Coffee Board.
3. Arusha.
4. Oldeani.

Recording of off-station trials was carried out at Usa River, Arusha, Msinga (Moshi Native Coffee Board) and Kirua Vunjo (Moshi Native Coffee Board).

Station Experiments—General

On the Research Station there are twenty-seven clonal and selection trials largely concerned with comparing the yield from seedlings and from trees raised from cuttings, four agronomic trials, and three trials of methods of pruning and training.

No new experiments were planted on the Station in 1952, but it was the first full year in which the modified treatments in the banana mulch and irrigation experiment (XV) were applied. The former lowest level of mulching (forty pounds per tree) and of irrigation (rainfall made up to two inches monthly) were not altered, but the other treatments have been lowered in accordance with the finding that the higher levels of irrigation and mulching gave no increased benefit. The minimum mulch treatment is now twenty

pounds applied in June and the minimum irrigation level is to make up the effective rainfall to one inch monthly. It is hoped that the new treatments will give some indication as to whether or not reduced applications will be as effective, or nearly so, as the former high ones. This information will be of considerable assistance in designing future trials.

The statistical analysis of the experiments and trials of selections for 1951 was completed in November and the results obtained show much the same trend as previously. In the experiments in which clones and seedlings are being compared by plots there is no significant difference in yields, this also applies when the clonal and seedling progeny of each of the parent trees in the experiment are compared.

Although elephant grass (as mulch) and sulphate of ammonia have, over a ten-year period, effected some increase in yield, compost is the only one of the three treatments to bring about a significant increase. Sulphate of ammonia when applied in combination with the elephant grass or compost depressed yields.

The yields in the experiment in which the effect of mulch (banana trash) and irrigation are the treatments, were generally at a lower level than in the seasons 1947 and 1948 but about the same as 1950. The exceptions were those plots receiving mulch only; these seem very prone to biennial bearing and it was their "on" year. Results from this experiment are available for ten years; mulch at forty pounds per tree and irrigation sufficient to make up the rainfall to two inches monthly both effect increases in yield of about fifty per cent. Combination of these two treatments still further increases the yield, there is however no advantage in applying higher rates of mulch or irrigation, singly, or in combination. It is noteworthy that the four clones in this experiment respond differently to the mulch treatments.

The pruning of shaded single stem coffee immediately after crop has, for a period of two years, effected an increased crop over that resulting from pruning at one month to five months after crop.

The multiple stem system of pruning has given, over a period of fourteen years, thirty-two per cent more coffee than the single stem system.

The records of the clonal progeny plots of twenty-four selections are now available for seven years. The trees in these plots may be considered as mature or approaching maturity from the fifth bearing year onwards. The poorest yielder of these had a mean yield at the rate of 9·7 cwt. of clean coffee per acre for its fifth, sixth and seventh bearing years. In some cases 16 cwt. has been exceeded in each of the three seasons; the L1 progeny plots, for example, yielded 18·12 cwt., 16·33 cwt. and 18·56 cwt. per acre in the respective seasons.

Very high yields were recorded in the seedling progeny plots of some of the selections. In one case, H61, a yield at the rate of 31·75 cwt. of clean coffee per acre was recorded and there were several instances of yields exceeding a ton to the acre.

No positive results were obtained as to the access of "fruity" or "onion" flavour, although there was an indication that certain selections were more susceptible to the "onion" or unclassified taints. "Woody" flavour was not found to be connected with the storage of coffee under conditions of high humidity.

The age of the tree from which the coffee is obtained does not appear to be a factor in quality.

There was a high incidence of amber and semi-amber beans in the 1951 crop and a large number of the selections produced beans of this type.

At the end of the 1952 season the possibility of replacing the normal fermentation process by the use of caustic soda, magadi soda or pectic enzymes, was the subject of a preliminary investigation by the chemist. Over a range of concentrations each one effectively removed the mucilage from the freshly pulped beans. The effect of these treatments on liquoring quality is being investigated.

Pests and Diseases

The *Antestia* population showed an unprecedented rise in May; the numbers do not usually start increasing until about September. Some of the worst areas were sprayed immediately with DDT but the general post-rains copper spraying, which took place in July and August also contained DDT when applied to all the untreated plots. In November only two out of the sixty-one plots tested showed the presence of *Antestia*.

White borer has now become a serious pest on the station. Five hundred and five borers were extracted and five hundred and thirty-five unextractable ones treated with E.D.C.T. mixture during the year.

A slight outbreak of thrips occurred as early as August and a severe outbreak happened in December in the young coffee on Blocks 32 and 33 Lyamungu Coffee Estate.

Mites have caused a good deal of leaf distortion on certain parts of the station, more particularly on the unshaded single stem coffee in Experiments V and XV, the multiple stem guard rows in these two experiments are affected to a very small degree.

Moles have done very considerable damage to the young coffee. Over six hundred were trapped in eight months, mostly in Experiments IIIB, XVIIIA and XXI, the three experiments which were planted in 1951.

Leaf miner incidence was heavy early in the year, but the trees soon recovered.

Hemeleia vastatrix was severe early in the year, after the extended short rains of 1951, but at the end of the year there was very little in evidence.

Vegetative Propagation

Owing to the heavy infection of the mother-trees with *Hemeleia vastatrix* only a limited number of cuttings were available.

The taking and recording of cuttings in the monthly planting experiment initiated last year, was continued, in addition a new series in fresh rooting medium was started.

A second experiment using a growth substance, this time beta-indolyl acetic acid, was laid down in the frames.

The taking of cuttings from the new selections in Experiment II (Seedling Selection trials) and Museum plot for establishing as mother-trees was commenced.

Breeding

A start was made with the crossing of the most promising clones. Reciprocal crosses of H66, KP423 and N39 were made.

Lyamungu Coffee Estate

Approximately twenty-seven acres of Block 17, which was cleared of shade and from which couch had been eradicated in 1951, was planted with *Cynodon plectostachyum*. The balance of this block (three acres) was sown with oats. The grass planting was done by discing in the runners but it was found to be a rather uncertain method of planting because the discs clogged if too wet and the grass died if it was too dry. However, a fair stand of grass was finally established.

Investigation into the Causes of "Wither Tip" and "Dieback" at Mbosi

The observation plot in which mature coffee is sheltered from wind and sun or wind only, shows that such protection does not prevent the occurrence of either "wither tip" or "dieback". On the other hand growing the young coffee under greenhouse conditions practically prevents their occurrence but whether "black tip" will appear after the strain of flowering remains to be seen.

The Government Chemist has also been working on the problem and his recent work suggests a manganese-induced calcium deficiency. He is now investigating whether this nutritional disorder is directly responsible for "wither tip", "dieback" or both.

Seed

2,460 pounds of seed of the selections were sold to growers.

Animal Husbandry

7,336 gallons of milk were produced from thirty-seven cows and heifers in milk. The highest yield in any one day was 26·4 lb. One cow, Sitimu, yielded 419 gallons in 302 days; this was her ninth lactation.

There were nine cases of "fly" during the year, three of the affected beasts died.

Owing to shortage of labour no silage was made in 1952.

Forty-one calves were born during the year, seventeen being heifers. The calving rate of one per twelve months has been maintained.

Fruit

The deciduous fruit trees were again sprayed with a proprietary D.N.O.C. winter wash to break the dormancy to which such trees are prone at this altitude, where winter temperatures are comparatively high. The success of this treatment on the plums and apples was demonstrated. Over forty pounds of fruit were harvested from one tree of Methley plum, which had been planted in the orchard in 1948.

Cereal Trials

Eleven varieties of wheat, four of barley and two of oats were obtained from the Plant Breeder, Njoro for trial on the Station. They were planted in unreplicated plots of one-eightieth acre on Block 33, Lyamungu Coffee Estate. Two varieties of barley, Research and Glacier, gave excellent yields equivalent to 22·4 and 17·0 cwt. per acre respectively and two wheats 184 P. 2 A.1.A. and 350 A.D. 9 C. 2 gave 17·3 and 17·2 cwt. per acre respectively.

Prior barley gave 10·4 cwt./acre and Sabanero wheat 10·3 cwt. Two further wheats 318.0 3.B.2 and 321.BT.1.B.I gave 8·9 cwt./acre. The oats were badly damaged by birds.

F. R. Sanders,
Senior Research Officer

SISAL RESEARCH STATION, MLINGANO, NGOMENI
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Touring

The Plant Physiologist visited the Southern Province in March to investigate cyclone damage to sisal plantations. He also attended the Field Day at the High Level Sisal Research Station, Thika, Kenya, in order to give a talk on sisal deficiency diseases in addition to visiting a number of estates in the Tanga Province.

The Soil Chemist travelled widely in Tanganyika in order to become acquainted with the major sisal soil types and to take samples for subsequent analysis, besides making several advisory visits to estates. During October and again in December the Senior Research Officer and the Soil Chemist investigated soil conditions on several estates along the Central Line primarily in connection with the establishment of fertilizer trials. Both officers visited the Southern Province in November for studying soil problems.

The Senior Research Officer attended a Plant Breeding Conference at Njoro, Kenya, in September when the opportunity was taken of seeing the progress of trials at the High Level Sisal Research Station. He also visited estates in the Tanga Province.

During the year the Agricultural Assistants made routine visits to external trials situated in the Tanga and Eastern Provinces. Advantage was taken of one officer spending local leave in Kenya to purchase selected cattle for the Station.

Buildings

Building work was confined to the construction of thirty-two semi-detached quarters for Africans as an extension to the labour camp. Minor works mainly comprised interior alterations to the Soil Chemistry laboratory such as fitting extra benches and an extension of the water supply. Two artisans are employed regularly on the upkeep of buildings. Three faulty rain-water storage tanks were rectified by the building contractor who was responsible for their construction.

Water Supply

The rain water storage supply system to the laboratories proved to be adequate throughout the year despite a low rainfall. Apart from temporary shortages arising out of defective tanks, domestic water supplies were satisfactory.

At the beginning of the year the level of water in the dam was fairly high owing to heavy rains in 1951. The main rains did not add much to this supply but the dam rose to nine feet three inches in November which should suffice for the next six months.

Electricity and Gas

The electricity and gas installations functioned without any trouble.

Laboratory Equipment

Many indents for laboratory equipment, placed through the Crown Agents for the Colonies, London, were fulfilled during the year. Among the major items received were the medium spectograph, together with much ancillary equipment such as platinum dishes, etc., a micro-analytical balance and a modern weighing balance, drying ovens, glassware and chemicals. Outstanding orders for equipment include a large spectrograph (for minor elements) a flame photometer (for potash and calcium determinations) and a larger shaking machine (for soil phosphate analyses). The first item has been shipped from the United Kingdom. Steel filing cabinets and an electric calculating machine were also purchased. The Station is excellently equipped and will shortly have all the apparatus necessary for future needs.

Machinery and Field Equipment

A large new weighing machine was delivered for field work. The range of agricultural implements was increased by the purchase of a hydraulic lift and a 3-furrow disc plough for the Fordson tractor, and a field mower. A second-hand set of half-tracks were bought for the Fordson tractor. Messrs. Pest Control Limited left a tractor-mounted spraying machine for use in new trials to protect them from damage by the sisal weevil.

Library

The library comprises over 260 text-books on agricultural science and allied subjects. The Station subscribes to fifty technical journals which are bound into volumes as each set is completed. Over 6,000 references have been card-indexed according to the Universal System of Classification. The library is open to enquiries from sisal growers for any information which they may require on certain agricultural topics.

Clearing and Planting Work

Clearing of derelict rubber and bush can only be undertaken whenever other more essential work permits, usually during the dry season. This year some twenty-five hectares were opened up, mostly alongside the Kibaranga road to provide a fairly tsetse-fly free corridor for the cattle, and the remainder in front of the new houses sited in the centre of property. One hectare was cleared and stumped for a bulbil nursery.

Twenty acres of maize were sown in April as a food supply for labourers. The crop was a failure owing to poor rains and bad germination. The same area was resown in September with much better results although more rain would have been beneficial later in the year when the maize was in the cobbing stage. This crop has not yet been harvested. One hectare of beans sown during the small rains gave a disappointing yield. Two hectares of bananas planted last year in a valley have grown slowly owing to the dry weather but they are free of Panama disease. More hedges were planted in the grounds of the new houses. Developed areas were kept free of secondary bush growth and roads were graded and top-dressed with murram.

Citrus

Irrigation of the citrus nurseries is not possible at Mlingano and consequently 10,000 budded citrus trees suffered a severe setback owing to periods of drought. All available supplies of trees were exhausted by the middle of the year and the Station will not be able to resume deliveries until the main rains in 1953. 3,246 trees were sold to estates and other purchasers and there is still a considerable backlog of orders which continues to exceed the supply. The nurseries recovered during the November rains when the opportunity was taken to plant out a further 5,000 rough lemon stocks. Cattle manure is used annually. Mr. A. Jackson, Horticultural Officer, Department of Agriculture, Kenya, inspected the nurseries in September, afterwards making a generally favourable report. One of his recommendations was the raising of seedlings of selected orange trees growing in the locality in preference to budding on to rough lemon stocks because of their longer life and hardiness. Arrangements have been made with the Agricultural Officer, Tanga, for the selection of trees but collection of seed has not been possible yet owing to a poor crop of fruit.

The nurseries have kept free of pests and diseases except for scab which has been controlled by periodic spraying.

Bast Fibre Crops

Seed of sixty-two varieties of Hibiscus, including Kenaf (*H. cannabinus*) received from South Africa through the Department of Agriculture in 1951 and also through Messrs. Bird and Company (Africa) Limited was sown in multiplication plots last year. This enabled larger plots to be sown in 1952. Germination was poor and the drought had a parlous effect upon growth. Kenaf grew best but only where the soil had a good moisture regime.

The plots of ramie (*Boehmeria nivea* and *B. utilissima*) did not grow well this year under a low rainfall despite another application of cattle manure.

Cover Crops

The Station maintains fairly large plots of *Tephrosia candida*, Tropical Kudzu vine (*Pueraria phaseolides*) and *Centrosema plumieri* which were sown three years ago. The *Tephrosia candida* still provides a tall dense cover and it has only been necessary to eradicate small bush growth and climbing weeds once. The recumbent types, especially *Centrosema*, cannot compete satisfactorily with the indigenous grasses such as "Ukoka" (*Panicum trichocladum*) and hand pulling of weeds has been necessary. Seed production of tropical kudzu vine has been disappointing although this cover crop is now well established.

Elephant Grass

A large area of land previously under food crops or agaves is resting under a dense growth of elephant grass (*Pennisetum purpureum*). Certain parts are cut periodically to provide fodder for the cattle.

Livestock

A herd of cattle of various ages has been maintained on the Station for many years past. At the end of the year there were one grade Ayrshire bull, twenty-two cows and heifers, fourteen young stock and nine calves. The majority

are stall-fed in fly-proof byres but twelve animals have been grazing outside since November, 1950. None has died but latterly seven became infected with trypanosomiasis and are recovering after treatment. The calves have done well resulting from better methods of animal husbandry. The Ayrshire bull purchased last year has sired eleven calves, of which six heifers will later form the basis of an improved herd. Five in-calf Zebu heifers having parents of known milk propensities arrived from Kenya in December and in due course they ought to give higher milk yields besides producing larger progeny. 538 gallons of milk were sold during the year.

Weather

The average rainfall for the past eighteen years at Mlingano is 46·52 inches and prior to 1952 there had been only three dry years when the total rainfall was less than forty inches.

Nineteen fifty-two was another dry year having only 32·98 inches of rain which represents a shortfall of 13·58 inches. The year opened with hot, dry weather with scattered light showers which soon evaporated and were of small value for plant growth. The main rains failed to materialize in April while the precipitation during May, usually the wettest month, was most disappointing. Cooler but drier conditions prevailed until the latter half of September but the Station was never very parched for long owing to periodical showers. Good rains in November helped to reduce the shortage for the year which was then over fifteen inches. Dry, hot and windy weather in December resulted in the vegetation withering but at no time during the year did the sisal show drought symptoms.

Rainfall Records

	1952		18 years average	
Month	*Inches*	*No. of days*	*Inches*	*No. of days*
January	0·20	4	1·08	5
February	2·27	3	1·43	5
March	2·06	5	4·31	10
April	2·27	7	7·27	17
May	6·11	15	9·71	19
June	1·79	14	2·18	12
July	0·27	9	1·76	12
August	0·94	14	2·24	12
September	3·48	14	3·43	12
October	4·48	11	5·19	12
November	9·01	19	4·79	12
December	0·10	2	3·13	11
Total	32·98	117	46·52	139

No exceptionally heavy downpours of rain occurred during the year. The strongest winds prevailed during the north-eastern monsoon in January and the main rains period was slightly more windy than usual, there being little difference for the remainder of the year until December when wind measurements were considerably higher than those for the corresponding month in 1951.

The total number of hours of sunshine recorded varied little from previous years but the weather was most overcast during July and August instead of during the main rains. Soil temperatures fluctuated slowly, the difference

between the hot and cool season readings amounting to 6 degrees Centigrade. Both maximum and minimum temperatures of the atmosphere tended to be slightly above average particularly during the cooler months.

Programme of Experimental Work

The current programme of experimental work comprises thirty-six field trials of which nearly half are situated on outside estates. All but nine of these trials are concerned with the problems of manuring sisal and the maintenance of soil fertility. The Station also assisted in putting down trials on the Central Line for Dr. E. W. Russell, Oxford University, and are maintaining other insecticide experiments initiated by the staff of Messrs. Pest Control Limited.

Sisal is a monocarpic perennial or a plant which lives for more than two years and only flowers once during its life. *Agave sisalana* has a life span varying from four to ten years or more, depending upon its environment, and this fact imposes a severe restriction upon the rapidity of obtaining experimental results. For this reason many of the manurial trials started during the past two years have hardly got into their stride and few are ready for cutting yet. Nevertheless steady progress is being made in the elucidation of the fertilizer requirements of sisal on various soil types, aided by plant and soil analyses. Observations of foliar symptoms are giving some indication of responses to manures where cutting records are not available at this stage of the experiments. The Factorial Manurial trial at Mlingano and an external potash manuring experiment for banding disease are now yielding highly interesting results of practical importance.

Field Trials on the Station

The salient features of each experiment are given in the following review.

Cultivation Trial.—Started in 1936, this trial compares six treatments varying from continuous clean weeding to no weeding. First cycle yields (14·4 tons per hectare) favoured clean weeding but there was a marked decline (11·7 tons per hectare) during the second cycle. Still lower yields are likely to be obtained from the third cycle where the sisal has now reached leaf stage number 162 or about four-fifths of its estimated life, and has only yielded a total crop of 2·8 tons per hectare to date. This sisal is in a shocking condition and is suffering from every kind of deficiency disease and the history of these plots emphasizes the great dangers of a bare soil under tropical conditions.

With regard to the intermediate treatments the sisal has grown more slowly with increasing weed competition such as was observed during the first cycle. Fibre yields are lower during the second cycle compared with the first and the differences are of the same order of magnitude as that for the clean weeding treatments except in the case of the cover crop lots where the decline was less. Losses of early leaves were about the same or less than those for the first cycle due to cutting beginning earlier but the total number of leaves grown per plant was fewer. After allowing for seasonal differences and more extensive weevil damage, it is inferred from the second cycle results that a vegetal cover on the soil is not enough by itself to maintain soil fertility.

Second cycle sisal in competition with unrestricted weeds and bush is healthy. It has, however, grown extremely slowly and has yielded very little crop up to the present.

Third cycle sisal with a cover crop has made poor growth and banding disease is rife in several plots.

Spacing Trial.—The spacing trial is another of the original experiments begun at Mlingano seventeen years ago. It compares eight different plant populations ranging from 1,666 to 10,000 plants per hectare. First cycle results showed that total yields and plant population were closely related. Plots have been replanted as each cycle of sisal poled out.

The growth of the second cycle sisal has not been as good as that for the first cycle on virgin land but this is not reflected in the total yields from plant populations less than 5,000 per hectare mainly due to better cutting methods. Second cycle sisal planted more densely than 5,000 per hectare has not yet poled out but there are indications that the total yield will be less than that for the first cycle.

Third cycle sisal at low densities has made unsatisfactory growth and is suffering from deficiency diseases. The necessity to replant at comparatively short intervals arising out of early poling due to a low plant population has accelerated soil impoverishment since this has necessitated frequent weeding during the young stages.

Spacing × Cutting Trials.—The second cycle of the spacing × cutting trial is now over three and a half years old and all the plots have been cut. At present the three levels of plant population, viz. 4,000, 5,000 and 6,000 plants per hectare, show no differences in fibre yields and this is likely to persist until poling effects become evident. As might be expected plots cut early at two years from planting have given more crop to date than those cut later at two and a half or three years. Rates of leaf production are greatest for the low density sisal and they have not been influenced by commencement of cutting or cutting cycles but double-row sisal is about five leaves per plant behind single-row sisal; this has resulted in slightly lower fibre yields to date. Late commencement of cutting has led to losses of the lowest leaves through withering and lower fibre yields, and if combined with low plant population it is conducive to early poling.

The severity of cutting trial is five years old and heavy poling has occurred in the low density plots which have not been cut severely. The cutting treatments comprise cutting at one and a half, two and two and a half years from planting leaving eight, sixteen and twenty-four leaves per plant at cutting cycles of six, nine and twelve months, and these twenty-seven systems have been imposed on three plant populations, 4,000, 5,000 and 6,000 per hectare. Once again leaf production has varied inversely with plant population but it has not been markedly affected by the cutting treatments. Aggregate fibre yields to date do not differ widely although there are signs that heavy cutting every six months from eighteen months onwards is beginning to depress yields. Plants subjected to this treatment are smaller and are yielding shorter and lighter leaf containing rather less fibre than those cut in a more reasonable fashion.

In the early cutting experiment cutting begins at nine, fifteen and twenty-one months from planting and thereafter on cycles of six, nine and twelve months. Plant population and severity of cutting are the same as in the above experiment. The trial is sited on new land and the sisal has grown well.

Since it is only twenty months old not all the cutting treatments have been applied at present. "Sand" leaf cuts at nine months yielded very little crop even when the plants were cut heavily and practically none at all where lighter cutting was practised since all leaf less than sixty cms. long was discarded because it is too short to be decorticated easily. Such cutting is tantamount to a cultural operation which facilitates weeding and desuckering of the double-rows. Second cuttings taken six or nine months later yielded from 0·6 to 0·8 tons per hectare. Sisal cut at fifteen months from planting gave fibre yields varying from 0·1 to 1·0 ton per hectare depending upon the severity of cutting. Removal of the "sand" leaves only does not seem to have affected growth to any extent and the plants have a trim appearance. On the other hand plants cut heavily when still too young are already becoming noticeably dwarfed.

Similar cutting methods have been applied to single plants in the fibre characteristics trial for the past five and a half years. In this case plants cut lightly or normally from 40th leaf stage number onwards have not been greatly affected but those cut heavily are very small and stunted. Heavy cutting has resulted in short leaf weighing about half of that from plants cut less drastically while the amount of fibre per leaf has been reduced by nearly two-thirds. The fibre is finer and the fibre percentage is lower and it is clear that young sisal should never be cut heavily.

Fertility Trial.—Nine systems of rotating sisal with various resting crops are being tested in this trial. The fallow crops were planted nearly three years ago after one cycle of sisal on virgin soil. The *Tephrosia candida*, green manure, and certain of the elephant grass and natural vegetation plots were ploughed up this year and replanted with sisal. This later suffered so severely from weevil damage that it became necessary to replant last October and Messrs. Pest Control Limited kindly sprayed the second planting which is now growing satisfactorily. The elephant grass plots treated with fertilizers have provided a heavy mulch of dead material for protecting the soil but it is too early to report any results. Three treatments comprise continuous sisal growing, each being cultivated in a different manner. The sisal grew more slowly compared with its counterpart in the first cycle taking two and a half years to attain the 90th-100th leaf number instead of two years. Nevertheless the first cut yields compared with those for the first cycle being highest for plots kept clean weeded by hand and disc-harrowing. The sisal is spaced $4 \times 1 \times \cdot 80$ m. (5,000/Hectares) and on this occasion it appears that strips of grass (*Panicum trichocladum*) or a recumbent legume (*Glycine javanica*) have competed with the sisal to a small extent for soil moisture leading to lower yields at the first cutting. Clean weeding and disc-harrowing are not to be recommended because such methods destroy soil structure.

Grass Rotational Trial.—This experiment differs from the fertility trial just described in that it is sited on sisal-worn land and its object is to restore soil fertility through the media of grasses and fertilizers. Elephant grass (*Pennisetum purpureum*) and guinea grass (*Panicum maximum*) were planted eighteen months ago and given dressings of lime, nitrogen, phosphate and potash. These two sets of plots, which will be replanted with sisal next year, showed marked responses to nitrogen and phosphate and have provided a heavy mulch of organic matter. The grasses were either cutlassed or grazed at suitable intervals, the elephant grass having become thin owing to heavy grazing.

Another third of the experiment was planted with sisal and given the same fertilizers in order to compare direct with indirect methods of manuring and to ascertain whether the latter would avoid fixation of phosphate in the soil. This sisal is very uneven due to weevil damage soon after planting two and a half years ago. Growth records show that nitrogen has stimulated leaf production and eleven of the sixteen plots receiving this fertilizer have been cut so far, fibre yields varied from 1·0 to 1·9 tons per hectare. Plots without nitrogen are backward and chlorotic and none is ready for cutting yet. Sisal treated with lime and phosphate has a good colour. There has been no response to potash.

Factorial Manurial Trial.—This complex experiment was started three and a half years ago. The treatments comprise dressings of lime, nitrogen, phosphate and potash in every combination and each at three rates, viz. none, moderate and heavy dressings, all but the lime having been applied annually.

Each plot is cut separately as it becomes ready and the most forward ones were cut for the first time eighteen months ago when the sisal was two years old. The backward plots could not be cut until six months later and some of these are not yet ready for cutting again. A consequence is that complete yield data is only available for the first cutting although the majority of plots have been cut twice and a few three times up to the present time.

First cut yields showed small responses to nitrogen, phosphate and lime but none to potash; there was no difference between moderate and heavy dressings of nitrogen. Interactions between the fertilizers were not significant. There is clear evidence, however, that nitrogen has hastened growth because out of fifty-four plots receiving this fertilizer fifty-three have been cut twice and five three times, the latter yielding between five and six tons of fibre per hectare up to date. Such yields are comparable with results previously obtained on virgin land. Of the twenty-seven plots without nitrogen fifteen had been cut only once by the end of the year.

Plants lacking nitrogen tend to be chlorotic but excess nitrogen supplied in the form of sulphate of ammonia gives rise to symptoms of chlorotic mottling especially in the absence of lime or phosphate. Too much potash has also resulted in chlorotic mottling of the leaves but this deficiency disease does not generally lead to any stunting of the plant. Purple leaf tip roll, another deficiency disease, is present in varying degrees in all the plots being less marked where phosphate or lime have been applied but it becomes worse with increasing amounts of nitrogen. The exact cause of this disease is not yet known. Tests show that the fertilizer treatments have had no effect upon fibre fineness at the first cutting.

Fertilizer Placement Trial.—The fertilizer treatments in this experiment are confined to nitrogen and phosphate each of which have been applied in three ways (i) on the rows of sisal; (ii) on the grass cover strips between the sisal rows; and (iii) broadcast. Once again nitrogen has accelerated growth. The sisal is nearly ready for cutting and growth records indicate that the fertilizers are most effective if placed on the rows of sisal.

Mulching Trial.—The value of organic mulches and manures for sisal are being tested in this trial in comparison with a mixture of inorganic fertilizers. The sisal is three and a half years old and it has not grown exceptionally well as the area has carried sisal continuously since 1936. Soil variation is greater than is desirable for an experiment and this has favoured certain treatments in

spite of randomization of the plots. A second cutting was taken this year and the level of yields was not high. All the mulched plots are better than the controlled (untreated). Differences between cotton seed, coconut cake and elephant grass are small. Old sisal waste applied at the rate of fifty tons per hectare annually has fostered growth and current yields (2·5 tons per hectare), though not particularly good, are the best in this experiment, followed closely by those obtained when inorganic manures were used. It seems that mulches can be of some benefit in sisal cultivation but they are not necessarily enough in themselves to maintain fibre yields on exhausted soils.

Ridging Trial.—Double-row sisal planted on ridges has grown faster than that planted on the flat but only during the first two years of the experiment. Ridged sisal has yielded ten tons to date over four cuttings compared with 7·9 tons per hectare for that on the flat; it is likely however, that it will pole out sooner. As this trial has a plant population of 6,000 per hectare it is expected to provide a further two or three cuttings before it is finished. Light post-cutting dressings of fertilizers have not affected fibre yields.

Interplanting Trial.—Maize, sorghum and beans were intercropped between sisal planted in single and double rows during the first two years after the trial was started in 1949. A second cutting was taken this year and current data indicates that sorghum has had a significant depressing effect upon the growth and yields of the sisal. This is primarily attributable to severe competition for soil moisture when the sisal was young. Sisal interplanted with maize has yielded less than the control (no crop) but the difference just fails to be significant. Beans have had no effect. Neither single or double row spacing, nor fertilizers applied to the foodcrops, have had any effect upon fibre yields to date.

Bulbil Nursery Manurial Trial.—This experiment was repeated for the third year in succession on the same land and after one year the plants were lifted and weighed. The results confirm those of previous years showing that wide spacing (50 × 25 cms.) makes for larger plants than narrow spacing (30 × 25 cms.). Old or fresh sisal waste, each applied at a rate of fifty tons per hectare, led to doubling the size of the plants irrespective of the spacing, but when used together the plants were three times larger for the narrow spacing and four times larger at the wide spacing. It is felt that these improved results are partly ascribed to the residual effects of previous applications of sisal waste. Once more nitrogenous and phosphatic fertilizers did not affect growth.

Sisal Waste Manurial Trial.—A new experiment was put down this year to ascertain the value of sisal waste as a manure for improving the fertility of land which has been growing sisal for many years. Comparisons are afforded between (i) the entire waste effluent as it leaves a decorticator; (ii) the solid portion only and (iii) the liquid waste, as might be obtained from one hectare or 400 tons of leaf. This is roughly equivalent to the weight of leaf removed during one cycle of sisal. There is one extra treatment consisting of the application of fifty tons per hectare of solid waste supplemented with nitrogenous and phosphatic fertilizers. The waste was put down a few months before planting and ploughed in later. Up to the present there have been marked responses in growth to the entire waste and the solid waste. The young plants are growing faster and possess a good colour. Liquid waste alone has not had much effect upon growth. This trial was sprayed by Messrs. Pest Control against the sisal weevil.

Agave Hybrid Comparative Trials.—Two experiments for testing selected agave hybrids are in progress, one begun in 1949 and the other a year later. The former was cut for the first time when it was two years old. Out of nineteen selections four gave promising results, one yielding over two tons of fibre per hectare. Many of the selections in the second trial have produced up to twice as many leaves as ordinary sisal but they are much shorter.

External Trials

Spacing × Cutting Trials—Central Line.—The spacing × cutting trial in the Kilosa District which was begun in 1944 is nearly finished. Total fibre yields have been good, ranging up to eighteen tons per hectare for plant populations of 6,000 per hectare. In all other respects the results follow the trend of a similar experiment at Mlingano.

The second spacing × cutting trial near Morogoro has not grown so well. Extensive poling has taken place in the 4,000/hectare plots and on sites of high soil fertility.

Grass Rotational × Manurial Trial—Tanga Coast.—The grass rotational × manurial trial on a sandy soil in the coastal belt which has been in progress for two years was ploughed and replanted in September. Two past attempts to plant sisal on this plot were unsatisfactory owing to severe weevil damage and the low fertility status of the soil. On this occasion it was decided to plant prior to the small rains in order that the young sisal would be well developed by the following June and thereby be less susceptible to damage when the weevil population could be expected to be at its peak. Planting took place under dry conditions but a few showers shortly afterwards, coupled with the November rains helped to get the plants established. The trial was also sprayed by Messrs. Pest Control. These measures appear to be meeting with some success because up to the present there are no vacancies and the sisal is not growing badly.

The soil has proved to be too sandy for the grasses to build up much structure but they have provided an excellent mulch for protection of the topsoil. The grasses had previously been dressed with ground limestone, nitrogen (sulphate of ammonia) and phosphate. Analyses made by the Soil Chemist indicate that the pH of the soil has been raised appreciably from 5·6 to 7·0 by the dressings of ground limestone whereas it has been lowered to 4·7 through heavy applications of sulphate of ammonia. The phosphate status of the soil is good where this fertilizer has been used. The extent to which soil fertility has been improved and its effect upon future yields remains to be seen although incipient signs of responses are visible at the moment.

External Exploratory Manurial Trials.—Last year the Station was responsible for conducting six exploratory manurial trials in various parts of the Tanga Province and this year another trial of the same kind was put down in established sisal in the Morogoro District. Each trial is sited on a different soil type. Those near the coast suffered from weevil attack and were replanted and sprayed, with better results. The uniformity of two other experiments was marred by mole damage. The same design of experiment has been used throughout and the treatments comprise dressings of lime, nitrogen, phosphate, potash and sisal waste. A 3 × 3 × 3 manurial trial is in progress on sisal land previously cleared by bulldozing.

These trials are not yet ready for cutting and the effects of the manures can only be judged from foliar symptoms. As might be expected the responses are not the same in all cases but nitrogen appears to have been beneficial irrespective of soil type except where the potassium content of the soil is marginal and this plant food has not been supplied. On acid soils lime and phosphate have improved leaf colour.

Banding Disease Manurial Trials.—A "banding disease" manurial trial on an estate having a dark-brown clay loam soil, which dates back to 1947, was cut for the fourth time this year. Aggregate yields show a large response to potash amounting to four and a half tons per hectare as a result of applying a total quantity of 1,100 lb. of Sulphate of Potash since planting. Plots given potash yielded at the rate of twelve tons per hectare whilst those without potash and suffering from banding disease, have yielded only seven and a half tons up to the present time. Responses to nitrogen and phosphate were not significant.

A new manurial trial in connection with this deficiency disease was begun this year in the same locality with a view to determining the most economic rates of using potassic fertilizers.

Grass Rotational × Manurial Trial—Korogwe District.—Owing to erratic rains establishing grasses in this trial has not been easy and it is difficult to see any responses to the fertilizers applied. The guinea grass plots have grown better than those planted with elephant grass.

Fertilizer Demonstrational Plots. Two fertilizer demonstration plots in large sisal on an estate near Korogwe have been disappointing. Two additional plots were started in younger sisal on two estates on the Central Line, one on bulldozed land suspected of lacking nitrogen and phosphate.

Plant Physiology

(*By E. C. Diekmahns*)

During the absence of the Senior Research Officer on home leave a part of the time was devoted to administration of the Station and the supervision of field trials. The latter half of the year was occupied with an intensive programme of leaf analyses in the study of the deficiency diseases of sisal.

Tissue tests of sisal in the factorial manurial trial were completed in respect of phosphate, potash and calcium. Nitrogen was not determined due to a lack of the requisite equipment. The results show a clear relationship between the application of phosphate and potash and the content of these nutriments in the leaf. In addition the uptake of phosphate is seen to be conditioned by the presence or absence of nitrogen; the uptake being greater with higher levels of nitrogen.

Banding Disease.—All plots in the banding disease manurial trial were sampled and the analyses showed a close relationship of the potassium content in the leaves to the application of potassic fertilizer and also to the yield of fibre. It has been found possible from the edaphic factors of this trial, to decide on the zone of critical potassium content of the leaves below which banding disease occurs and above which there is no increase in yield. The importance

of fixing this zone (0·5 –0·7 per cent potassium based on oven-dried material) lies in its use for the diagnosis of the fertilizer requirements of sisal. At present its use is confined to the soil type on which the sisal of this trial is growing but further analytical data not yet completed suggests that it may have a wider application.

Purple Leaf Tip Roll.—In a study of the factors which cause purple leaf tip roll, the analytical data has shown a complex picture. The details of this picture may be classified as follows:—

(a) Analyses of healthy leaves and leaves with purple leaf tip roll for nitrogen, phosphate, potassium, calcium and magnesium have shown no striking differences. Two features were however noted—the potassium content was *always* lower and the phosphate content *usually* lower in the leaves showing the symptoms.

(b) Using a scoring system for incidence of purple leaf tip roll in the factorial manurial trial, it is seen that lime lessens the symptoms while nitrogen, as sulphate of ammonia, makes them worse. This suggests that the acidity of the soil may be involved. The influence of soil pH (figures obtained from the Soil Chemist) on the incidence of purple leaf tip roll has been tested statistically and a low but significant correlation was obtained.

(c) Evidence from field observations has shown that purple leaf tip roll is always more severe and more widespread on plants with chlorotic mottle which is in turn associated with soils with a low calcium status.

Following on the evidence of (b) and (c), it may be argued that the high acidity (or low pH) is causing a toxic uptake of one or more of the trace elements. Work is proceeding along these lines to attempt to produce artificially the symptoms of purple leaf tip roll.

Chlorotic Mottle.—Analyses of leaves with chlorotic mottle have shown a consistently low calcium and magnesium content. A correlation of soil pH and the incidence of this symptom in the factorial manurial trial has given proof of a low but significant relationship.

Leaf Injection.—A further comprehensive range of leaf injection with all the major plant nutriments of leaves with deficiency symptoms has again produced negative results.

As noted above, injections of trace elements to produce toxicity levels in sisal leaves is at present being undertaken.

Sand Culture.—Pot experiments using nitrogen, phosphate, potash and calcium each at three levels were started three months ago and they are already yielding most interesting results. No quantitative data is as yet available but large differences in growth are to be seen. In addition leaf symptoms indicative of unbalanced growth have appeared.

Two further culture trials are in progress; one relating to toxicity levels of trace elements, the other an attempt to produce mineral deficiencies in very small bulbil plants.

Root Promoting Substances.—The three field trials on the effects of benzene hexachloride and various root promoting substances have been completed.

The summarized results are as follows:—

(a) Benzene hexachloride at fifty-six and seventy pounds/acre of a 2·6 per cent gammaisomer powder has a significantly depressing effect of twenty per cent on the weight of bulbil plants after fifteen months growth.

(b) Indol acetic acid at twenty and forty parts per million and indol butyric acid at forty ppm. increased the weight of bulbils by twenty per cent after fifteen months' growth. The bulbils were soaked in these chemicals for twelve hours before planting out.

Naphthalene acetic acid at ten ppm. had a depressing effect on the weight of bulbil plants.

(c) In the combined benzene hexachloride × rooting substance trial the depressing effect of the insecticide on plant weight was the only significant result. The root promoting substances were apparently unable to counteract the effects of the benzene hexachloride.

Bole Rot.—A field trial to test the efficiency of several commercial and experimental fungicides in the control of bole rot has produced disappointing results. All plants inoculated with *Aspergillus niger*, whether sprayed with fungicide or not, succumbed to the effects of the fungus.

Fibre Studies.—In order to find if the manurial treatment had any effect on the number of fibres in the leaves of plants in the factorial manurial trial, a series of fibre counts as seen in an enlarged cross section of the leaf were made. Results show that the potash treatment had a significant effect on increasing the total number of fibres per leaf. This finding needs further investigation which will be carried out next year.

Soil Chemistry

(*By F. Leutenegger*)

At the beginning of the year the Soil Chemist studied the geology of the eastern part of Tanganyika where the majority of sisal estates occur. Concurrently soil sampling equipment was prepared and the laboratory was reorganized within the limitations of the apparatus which was available at that time.

Soil sampling started from the middle of February onwards. Thirty-seven estates were visited including twenty-three on the Tanga Line and fourteen on the Central Line, and one week was spent in the Southern Province. A total of 1,433 soil samples were collected, comprising 677 samples from sisal estates and 755 samples from plots in the fertilizer trials at Mlingano as well as those on estates. In six cases new land was examined in order to report on their suitability for sisal cultivation.

In the laboratory the samples have been sieved, bottled and provisionally grouped into eight groups of soil according to their parent-rocks and the development of the soil. Determinations of soil pH (acidity) and of the total nitrogen content of all the samples was completed during the year. The determination of the acid-soluble and absorbed phosphate has been started and is now in progress.

The results of this work show that sisal is grown on soils having a wide range of acidity but it is quite clear that sisal prefers a neutral or even an alkaline soil which is rich in calcium. Analyses of samples taken from fertilizer

trials indicate that sulphate of ammonia, which has been used as a nitrogenous fertilizer in these experiments, decreases the pH and therefore it is unsuitable for soils which are not buffered with carbonates. The nitrogen content of top-soil samples varies from 0·05 per cent to 0·45 per cent nitrogen and soils having a pH more than 6·5 are usually better supplied with this plant nutrient. Further comment on these soils cannot be given until analytical data for the other major elements is available.

Two pot experiments for studying the evaporation and percolation rates of water for different soil types together with various soil mulches were completed and the results have already been reported.

Two trials in connection with composting sisal waste were also carried out and the second trial will be finished soon. In the first trial it was noted that the addition of nitrogen or any other artificial fertilizer does not hasten the process of composting. The pH of the fresh waste was 4·5, or distinctly acid, while the pH of the final product was 8·5 to 9·5, or alkaline, due to the decomposition of the organic acids in the waste. Composted sisal waste would accordingly be an excellent manure especially on acid soils.

Plant Breeding

Inter-specific crosses of F_2 *A. amaniensis*×*A. angustifolia* hybrids could be started this year when selected plants poled. Seed of twelve crosses has been sown in nursery beds. Suckers of nearly fifty selections were planted out in multiplication plots of one thousand plants each. The plants in these plots are in various stages of development and in due course there should be a greater overlapping of poling thereby increasing the range of crosses that can be made. One F_2 hybrid (No. 11648) is a promising plant which yielded 560 leaves of good length and conformation and this is being propagated vegetatively. The Station is also safeguarding a number of hybrids now growing at Amani which were inherited from the East African Agriculture and Forestry Research Organization. Some of these plants will provide valuable parent material in future years. Others are poling and pollination work is in progress.

Planters' Day

Planters' Day was held on 9th October and was attended by nearly 150 visitors who were shown round the field trials. Talks and demonstrations were given by the Plant Physiologist, the Soil Chemist, and Mr. D. G. Ashby of Messrs. Pest Control Limited, which proved to be of considerable interest. An exhibit of diagrams, specimens and models was arranged in one laboratory. The next day a large party of African employees from sisal estates was taken round the Station and given refreshments afterwards.

Publications and Reports

Half-yearly progress reports were submitted to the Research and Mlingano Management Committee and later circulated by the Tanganyika Sisal Growers' Association to all sisal growers. The Senior Research Officer wrote a note on the uses of sisal fibre as supplement to a lengthy report on sisal cultivation in Tanganyika which was prepared last year. Other memoranda written include one on the progress of sisal research at Mlingano and an account of the proceedings on Planters' Day. Mrs. M. M. Wallace, Assistant Plant Pathologist,

Lyamungu, and Mr. E. C. Diekmahns, Plant Physiologist, submitted a joint article on "Bole Rot of Sisal" which was published in the *East African Agricultural Journal*.

Malarial Control

The Malarial Research Unit, Amani, assists the Station in the application of control measures against malaria. Trees of *Lagerstroemia speciosa* planted near the edge of the dam finally died after being submerged for over six months but those on higher ground have survived.

Department of Agriculture and East African Agriculture and Forestry Research Organization

The Department of Agriculture seconded four Senior Service and seven Junior Service Officers to the Station as in former years. In addition copies of scientific papers were supplied and Crown Agent indents were forwarded by the Department.

Close contact was maintained with the East African Agriculture and Forestry Research Organization, Muguga, who advised the Station on a number of technical matters. The organization continues to use a plot of land at Mlingano for testing cassava hybrids for resistance against mosaic and brown streak diseases.

The Station carried out three maize fertilizer trials under a scheme continued by the Department. Two failed owing to drought.

The Director, East African Industrial Research Board, Nairobi, and his staff have helped in connection with local supplies of fertilizers and other substances.

Entertainment

The Tanganyika Sisal Growers' Association gave a luncheon party for the Minister of State for the Colonies, Mr. A. Lennox-Boyd, at Mlingano on 13th January which was attended by His Excellency the Governor, Sir Edward Twining, K.C.M.G., M.B.E. Another luncheon party was held on 3rd June for His Excellency the High Commissioner of Madagascar and Madame Bargues.

Acknowledgments

The Station wishes to acknowledge the ready co-operation of Messrs. Noorani Plantations Limited in providing decorticating facilities at their Ngomeni Estate whenever required. Thanks are also due to Messrs. Amboni Estates Limited for making some apparatus in their workshops and other estates for assistance on various occasions.

G. W. Lock,
Senior Research Officer

ANNUAL REPORT OF THE ENTOMOLOGIST, LYAMUNGU, FOR 1952

With the appointment of a second entomologist in the Northern Province it has been possible to devote more time to the major coffee pests than in previous years.

The most devastating pest, white coffee borer (*Anthores leuconotus* Pasc), has continued to extend its boundaries in spite of serious attempts to control it. The natives on Kilimanjaro, with their beetle collecting campaign in which a price per head of beetle has been paid, and the enforced destruction of larvæ have reduced the infestation considerably but, it is considered, not adequately to reduce the damage to negligible proportions. Estate owners are finding it increasingly difficult and expensive to control the pest owing to the shortage of labour. In some cases owners who have been waging a losing battle against the pest have been apathetic towards it and in such cases it has been recommended that uprooting should be enforced. The lower part of the Coffee Research Station can now be regarded as being within the "borer belt" and this has reminded coffee growers above the belt that the pest cannot be controlled purely by cultural practices.

Certain aspects of the biology of the pest have been studied and some of the more outstanding observations are summarized here. The ratio of male to female beetles which emerged during the long rains was 1 : 1 but the peak male emergence period occurred earlier than the peak female emergence, that is, male beetles tend to emerge earlier from the trees than the females. Larval mortality was also studied and observations in one estate showed that forty-five per cent of the larvæ which actually enter the wood never reach maturity. Pupal and pre-emergence mortality is very low.

In native coffee it is estimated that eighty-three per cent of the beetles which successfully emerged from coffee stems must have spent the major part of their larval cycle, including the ring-barking stage, below soil level. Eighty-nine per cent of the larvæ are estimated to spend at least a portion of their cycle below ground level. The corresponding figures in one estate in the lower part of the belt was forty-six per cent and fifty per cent. In general the observations of earlier entomologists were confirmed in that in the warmer low-lying areas the larvæ tend to live below soil level while at higher and cooler altitudes they tend to live well above soil level. It is impossible at the moment to correlate figures of larval positions to different altitudes because of the multiplicity of other factors including methods of cultivation, shade trees control measures employed and age of trees.

Control by Chemicals.—The results of the trial laid down at Arusha towards the end of 1951 were noted during the early part of 1953. DDT, Dieldrin and Toxaphene were sprayed at similar dosage levels (one per cent emulsion) on the stem of coffee trees. Effectiveness of the treatment against the female beetle was estimated by counting the number of eggs and early stage larvæ found in the trees by dissecting away the bark. The results showed that there were significantly fewer larvæ in the DDT and Dieldrin treated trees than in

the Toxaphene treated trees and control. Dieldrin was apparently more effective than DDT but this could not be verified statistically. No unhatched eggs were found. The control obtained, however, was not considered to be sufficiently satisfactory for commercial use.

DDT and Dieldrin were the only insecticides used for the three experiments on Kilimanjaro during the long rains. A brief account of each follows. In Experiments I and II results of the treatments were estimated by counting the living ringbarking larvæ after dissecting away the bark as above.

Experiment I.—To test the efficiency of three insecticidal formulations in the field.

The site chosen was a block of comparatively neglected coffee, some thirty acres in extent, in the lower part of the borer belt. Treatments were as follows:

A 2% DDT emulsion. Sticker:—15-9 L.P. resin of Petrochemicals. Ratio of Insecticide: sticker = 7:1.
B 2% DDT emulsion. Sticker:—water white gum resin. Ratio of Insecticide: sticker = 5:2.
C 2% Dieldrin. Sticker:—water white gum resin. Ratio of Insecticide: sticker = 5:2.
D Control—trees untreated.

Each insecticide was sprayed at approximately 200 c.c. per tree. All trees were single stemmed.

Each treatment was replicated six times.

Each of the six major plots contained four sub-plots of $4 \times 4 = 16$ trees the latter being separated from each other by two untreated guard rows. All treatments were randomized.

The results of the experiment are summed up in Table I.

TABLE I

Number of Larvæ per Sub-plot

Treatment:—	A	B	C	D
Plot No. 1	0	0	0	4
Plot No. 2	0	1	1	5
Plot No. 3	0	0	0	2
Plot No. 4	1	0	0	10
Plot No. 5	1	0	0	1
Plot No. 6	0	0	0	2
Total ...	2	1	1	24

The results could not be usefully analysed statistically and the only conclusions that could be drawn were that all insecticidal treatments were better than control and that all formulations were equally efficient.

Experiment II.—To test the relative efficiency of DDT and Dieldrin at similar dosage rates and the efficiency of two stickers. No control plot to be used.

The site selected was the "Single Tree Progeny Plot" of the Coffee Research Station. This plot has become increasingly infested over the past four or five years. All trees were multiple stemmed.

The treatments are as follows:—

A=2% DDT. Sticker: water white gum resin. Ratio of insecticide: resin=5:2
B=2% DDT. Sticker: 15-9 LP resin. Ratio of insecticide: resin=7:1.
C=2% Dieldrin. Sticker: water white gum resin. Ratio of insecticide: resin=5:2.
D=2% Dieldrin. Sticker: 15-9 L.P resin. Ratio of insecticide: resin=7:1.

All emulsions were sprayed at approximately 150 c.c. per tree. The main stem and the lower parts of the multiple stems only were sprayed.

The plot was divided into $6 \times 4 = 24$ sub-plots each of $5 \times 5 = 25$ trees. All treatments were randomized except the few remaining trees on the east side of the plot which could not be included in the sub-plots and these were treated with a two per cent DDT emulsion without stickers.

At the conclusion of the egg-laying season the trees were examined. In the "A" treated trees only one larva was found, "B" treated trees three larvæ, "C" treated trees one larva and "D" treated trees zero. The total number of larvæ in DDT treated trees was four and Dieldrin one only. The total larvæ found in which w.w. gum resin was used as a sticker was two, 15-9 LP resin three larvæ.

Once again the results could not be analysed.

It is interesting to note that, in a plot adjoining S.T.P.P. which was not sprayed, from fifty trees selected at random (excluding *C. robusta* trees) thirteen ring-barking larvæ were found.

Experiment III.—To evaluate the relative toxicity of DDT. and Dieldrin at two dosage levels and the relative values of w.w. gum resin and 15-9/LP resin as stickers against the beetle under field conditions: the insects being introduced to the trees at given periods.

The following formulations were used:

A1=1% DDT emulsion, w.w. gum resin as sticker.
A2=2% DDT emulsion, w.w. gum resin as sticker.
B1=1% DDT emulsion, 15-9LP resin as sticker.
B2=2% DDT emulsion, 15-9LP resin as sticker.
C½=½% Dieldrin emulsion, w.w. gum resin as sticker
C2=2% Dieldrin emulsion, w.w. gum resin as sticker.
D½=½% Dieldrin emulsion, 15-9LP resin as sticker.
D2=2% Dieldrin emulsion, 15-9LP resin as sticker.

In each case the amount of sticker used was two parts to five parts of insecticide by weight in the case of w.w. gum resin, of one part to seven parts by weight of 15-9LP.

Approximately 250 c.c. of each of the above emulsions were sprayed separately on the stem of single stem coffee trees before the rains had commenced and before beetles were due to emerge. A mosquito net was then placed over one tree of each treatment and six male and six female beetles were later introduced to each covered tree. The beetles were left in the sleeves for forty-eight hours and then placed individually in recovery cages for a further forty-eight hours. The numbers of dead and moribund beetles were noted after each twenty-four hours and if a moribund insect recovered this was also noted. A series of exposures were planned for the whole period of beetle activity but unfortunately the series had to be curtailed. An adequate number of insects was forthcoming from the organized collectors of the Moshi Native

Coffee Board (Hai division) but unfortunately the vast majority of insects while being taken from the tree had lost tarsi and sometimes whole appendages and thus could not be used. Also the beetles while being transported in cages fought vigorously causing further damage. Consequently all beetles had to be collected by trained assistants and each was caged separately or with one beetle of each sex in one cage. Using this material it was possible to obtain a small series of results. Conclusions drawn were that a two per cent Dieldrin emulsion was significantly more efficient than two per cent DDT against female beetles, Dieldrin effecting a 99·5 per cent kill and DDT an 82·7 per cent kill ($P = 0{\cdot}01$). At the lower level half per cent Dieldrin was more effective than one per cent DDT, Dieldrin giving a mean 77·4 per cent kill and DDT a mean 57·3 per cent kill. ($P=0{\cdot}01$). It was also noted that in all cases more female than male beetles were poisoned. No differences could be found between the value of the stickers. At all the dosage levels used the females were always able to lay one or two eggs before the insecticide could take effect. All formulations were still toxic to beetles after 16·8 inches of rain and forty-three days exposure. Dieldrin was still effective after twenty-four inches of rain and sixty days exposure but DDT was less effective.

Discussion

Whilst there is little doubt that the borer can be controlled with insecticides a great deal more data is required before a recommendation without reserve can be given to farmers. It is felt, however, that there is little more to be gained from small-scale field trials and that plots of several acres in extent will be necessary to obtain significant differences between varying dosage levels and different insecticides. This will necessitate finding another method of estimating the control effected as obviously many acres of trees cannot be examined for ring-breaking larvæ: each tree requiring from twenty to thirty minutes for a thorough examination by trained assistants. It may be necessary to assess results by counting emergence holes eighteen months or two years after treatment. At the same time new formulations and insecticides must be tried as soon as they are available and it is proposed to test insecticides contained in an ureaformaldehyde resin in 1953. Present indications are that the cost of controlling the pest with chemicals will be in the region of sixty shillings to eighty shillings per acre per year. Many farmers are prepared to pay sixty shillings per acre per year and some twice that amount. It is considered, however, that this will be too costly for peasant coffee growers, especially as there is no call for economy of labour when the small-holdings are maintained by the family. Instead, if the trees' roots could be protected by the use of fumigants or volatile insecticides the problem would be mostly solved as larvæ which live above soil level can readily be detected by a vigilant eye. This method may also be useful to planters who are not too seriously affected by the pest. Experiments on these lines will be initiated in 1953.

The Insecticide and the Tree.—So far none of the formulations used have caused phytotoxicity to coffee and no flavours have yet been detected by the liquorer in the roast or brew in any of the numerous samples taken.

It has been confirmed that if coffee foliage is sprayed with a highly persistent DDT emulsion containing stickers the trees in many cases soon become heavily infested with scale. The insecticide sprayed on the stem only does not induce a scale infestation.

The amount of insecticide sprayed on the bark of the coffee at the rates used above are in the region of one gm. per square foot. This dosage is exceedingly high and analysis by Dr. Robinson of the Colonial Insecticide Research Unit, Arusha, has shown that a very high proportion of the chemical (up to fifty per cent) is actually contained within the bark and to a lesser extent in the bast and wood. It was found in the treated trees of Experiments I, II, and III that in addition to the few living larvæ found there were also a few dead ones. The whole problem of penetration in the bark and the consequent effect on ringbarking larvæ will have to be investigated more fully.

DDT in the Soil and Phytotoxicity to Coffee.—After noting cases of soil which was "DDT sick to fruit trees" in the U.S.A. it was decided to test on a small scale the effects of DDT in the soil in coffee plantations. DDT wettable powder was added to the soil surface at the rate of 100 and 200 lb. acre to two small plots of four trees. So far no signs of damage to the trees has been noted and the crop ripened normally. Weeds growing under the trees also appeared to be totally unaffected. Liquoring tests will be made from the coffee beans.

Another small scale test was made in the laboratory with coffee seed. DDT was added to the soil at the rates of 0, 20, 40, 60, 80, 100, 200 and 400 parts per million parts of soil in glass dishes. There were two replicates at each level and ten seeds were planted at standard depths in each dish. No difference in germination were observed but with the lower levels of DDT the growth rate of the seedlings was higher than control and lower in the higher concentrations. At 400 p.p.m. level growth was almost completely retarded. Detailed observations were made and each plant was weighed and measured at the end of the experiment but these data have not yet been analyzed.

B.H.C. and "Brickiness".—It is now generally accepted that Technical B.H.C. applied to coffee can cause an off-flavour known as "bricky". With the production of Lindane formulations (i.e. ninety-nine per cent pure gamma isomer of B.H.C.) it was decided to test these products for off-flavours. Experiments were laid down using blocks containing four trees. Results are not yet available.

Other Coffee Pests

Antestia lineaticollis.—Several cases of DDT failing to control this Pentatomid were reported but in each instance in the Northern Province the fault lay with application rather than any DDT resistance shown by the insect. There was an exception, however, at Ngara in the Lake Province when twice the normal amount of insecticide failed to control the pest. The specific name of this *Antestia* remains undetermined but probably as the insect was found in hundreds on each tree there it is unlikely to be *A. lineaticollis*.

Acarina.—Three species of phytophageous mites have been found on the Coffee Research Station. The most important of these, *Hemitarsonemus latus* Banks has caused severe local damage, and progress of this pest will be watched with interest especially after the major mite outbreaks in orchards in the United Kingdom. A more detailed report has been published.

Berry borers.—The Pyralid *Thliptoceras octoguttalis* has been more in evidence this year than in previous years throughout the Northern Province. A new species of moth, *Phycita* sp. n. has also been observed in small numbers.

The former pest is believed to be controlled normally by parasites and several species have been bred out in the laboratory.

Orthesia insignis has continued to be a pest in certain areas in Kilimanjaro and in the Arusha District. More *Hyperaspis jocosa* were liberated in the more severely affected areas. The problem was reviewed with Dr. F. Simmons of the Commonwealth Institute of Biological Control during his visit to the Coffee Research Station and it was suggested that other predators and a parasite should be imported from the West Indies. It is proposed to do this.

Maize Production

With the increasing cost and scarcity of labour many farmers are considering the possibilities of mechanizing maize production. Successful mechanized harvesting depends to a large extent on the regular planting intervals and continuous rows obtained by the use of mechanical planters. Usually in the Northern Province maize planting proceeds immediately after the first inch or two inches of continous rain when all available labour is put to hand-planting. With mechanical planting however it is not practicable to wait for the rain since tractors and drills are liable to become bogged down. Consequently pioneers of mechanization are "planting dry", that is before the first rains are due, and so long as conditions remain dry the seed is safe from insect attack. When dry conditions are followed by heavy rain the seed swells and germinates almost immediately and is then again safe from soil living insects. As is often the case, however, only a trickle of rain follows planting; the seed swells but does not germinate and in this state is very liable to insect attack. Many farmers have lost seed in this way and it was suggested that it might be possible to use insecticides to control the insect pests concerned.

In the short time available for investigating this matter it was found that the ant *Pheidole punctulata* was partially responsible for the damage. In the laboratory it was observed to destroy the embryo of maize and bean seed in the turgid condition. Undoubtedly other insects are also responsible but this was not proven.

The matter was discussed with a representative of an insecticide manufacturer who agreed to sending two formulations of B.H.C. seed dressing for use during 1953. Arrangements have been made to try these on ten farms sited on Kilimanjaro.

Maize stalk borer, both *Busseola fusca* and *Proceras argyrolepida* have for several years caused extensive damage to native-grown maize on the north-eastern and eastern slopes of Kilimanjaro. It was found that a very large population of larvæ persisted long after maize harvest in perennial sorghum used for marking boundaries and for soil conservation rather than for food. Arrangements were made for all such sorghum to be destroyed and a quantity of DDT dust has been ordered for treating the maize in anticipation of the attack continuing into 1953.

Beans (Dwarf).—Many natives on the lower slopes of the mountain reported that insects were attacking the root system of their beans causing them to die prematurely. On investigation it was found that several species of insects were causing severe damage to roots and this, together with drought or semi-drought conditions, prevented the plants from seeding at all.

The insects concerned were *Pheidole punctulata*, Elaterid larvæ (wire worms) and many beetle larvæ believed to be those of the Tenebrionid *Dasus simplex*. Unfortunately none of the larvæ survived the final larvæ instar in the cages.

Peas.—Considerable acreages of peas were planted in the Rongai division of Moshi by native farmers. An almost complete loss of crop was caused by the Aphid *Acyrthosiphon pisum*. Nothing could be done to save the crop since no sprayers were available. Had the machinery been available it is doubtful whether the crop could have been protected economically because of the lack of an adequate water supply in the vicinity and because of the haphazard method of planting which would not have allowed a tractor to pass without causing extensive crop damage. Parathion successfully controlled this pest in the entomologist's garden.

Tea.—Several Cossid larvæ were found in the wood of tea plants on the Usambaras and sent to this laboratory for breeding out. When the supply of tea wood at the laboratory was finished they continued to feed on coffee stems. The larvæ have not yet pupated.

Acknowledgments

Acknowledgments are due to Shell Chemicals for supplies of Dieldrin, Plant Protection Limited for DDT miscible concentrate, and Messrs. Petrochemicals for solvents and resin. My thanks are due to Dr. F. Simmons of the Commonwealth Institute of Biological Control for much advice during his visit, to the Commonwealth Institute of Entomology for identifying specimens, to Mr. J. I. Thompson, Agricultural Assistant, for advice on statistical analysis.

R. G. Tapley,
Entomologist

ANNUAL REPORT OF THE ENTOMOLOGIST, MOROGORO, FOR 1952

Staff

The writer was on duty at Morogoro until October when he proceeded on vacation leave. Safaris have been made in Northern, Central, Lake and Eastern provinces.

Mr. A. J. Jones continued the work he began towards the end of last year on tobacco cut worm in the Iringa District. In March he was transferred to Arusha for work on sucking bug damaging seed beans in the field and in October he took over the Lyamungu Laboratory during the absence of Mr. R. G. Tapley on leave.

The Entomologist's Assistant, Miss C. A. Blair, remained throughout the year at Morogoro and was engaged in work on insect cultures, supervision of recording by African staff and assisting in the laboratory work involved by grain storage investigations.

African staff have been stationed in the Southern Highlands Province and Northern Province. Tours have also been made in the Lake, Central, Eastern and Northern provinces.

Investigation and Development

Stalk Borers of Maize and Sorghum.—Enquiry has been made into the manner in which the Noctuid, *Busseola fusca*, F., and the spotted Pyralid borer, *Proceras argyrolepida*, Hmpsn, span the dry season between the main harvest and the next planting season.

Over a large part of the Territory, in such areas as Central, Lake and Western provinces, where the dry season is complete it would now seem that *Busseola* is able to survive in large numbers as full grown larvæ in the dry stems of sorghum and maize, ready to pupate with the onset of the first rains. It is not clear whether this resting stage is to be regarded as a diapause or not. Preliminary indications from laboratory breeding of *Busseola* are that given food and hence moist conditions no long resting phase is obtained and that the larval life-cycle is thereby considerably shortened. In the coastal region where regular heavy morning dew and irregular showers maintain out of season plantings and promote the tillering of sorghums cut in July or August young *Busseola* larvæ can be found at any time during the "dry" season. Further laboratory work on these apparent differences is proceeding.

Under laboratory conditions the spotted borer *Proceras* passes through its life-cycle much faster than *Busseola* and regular generations, each lasting approximately one month, have been obtained. It is not yet certain to what extent the larvæ can survive dry conditions but experiments on the question are planned.

Grain Storage.—The investigations begun on the underground pits in Morogoro in October of last year were continued and further observations were made on two other pits sealed in Dodoma and Moshi in January and March

respectively. After one year's storage the maize in the Morogoro pit was still in excellent condition. The infestations in the other two pits were considerably reduced by the carbon dioxide accumulation after sealing down, but leakage of the gas unfortunately allowed some survival to take place. The maize in both these pits however was in very good condition after six and three months' storage respectively. Enquiry into the reasons for the gas leakage is required.

Some preliminary observations of the changes in moisture content which take place in bag stocks in godowns belonging to the Department of Grain Storage were made in co-operation with officers of that Department. The indications were that some moisture loss, even in the centre bags of a large stock, did take place over a period of nine to eleven months but that this loss was not as great as had been formerly thought.

American Bollworm on Cotton.—As part of a programme to increase cotton production in Eastern Province demonstration field scale dustings against American Bollworm *Heliothis armigera* Hb. were carried out by Cotton Committee staff, with assistance from the writer on the timing of the applications.

Mechanical dusting of non-native cotton, using a Long Ashton drift duster, was to some extent vitiated by the growing conditions encountered by the crop and did not prove itself economic under existing conditions. Further mechanical dusting has been planned for 1953.

On smaller native plots demonstration dusting was done with rotary hand dusters using the same insecticide, ten per cent DDT plus three per cent B.H.C. in talc, as for the non-native shambas. The practical difficulties of organization which follow from the necessary careful inspection and timing of the first application in the schedule of dustings, combined with the dispersion and relative inaccessibility of the plots, became fully apparent during this work. Results of the dusting were not clear cut owing to the low incidence of bollworm experienced.

Tobacco Cutworms.—Tobacco cutworms have for a long time been a considerable trouble to tobacco growers in the Iringa District. Of the seven species of Noctuid larvæ collected in tobacco seed beds and fields it is probable that *Agrotis segetum*, Schiff, and *A. spinifera*, Walk, are most important. Observations on the general ecology of tobacco cutworms have suggested that a considerable reduction in their numbers could be achieved by proper attention to weed control in the fields. In insecticide trials ten per cent Toxaphene dust applied at the time of planting at a rate of twelve and a half pounds per acre proved very effective and unlike B.H.C. dust had no phytotoxic effect. The experiments are to be continued during the coming season.

Sucking Bugs on Beans.- Sucking bug damage was reported on beans in the Northern Province many years ago, in some cases associated with the fungus *Nematospora coryli* and in other cases not. It has now been found that the main insect concerned is the Coreid, *Acanthomia horrida*, Germ, although subsidiary damage is also caused by the Pentatomid, *Nezara viridula*, L. The damage is important in that beans intended for export as seed or for canning have to be rejected on account of their shrivelled or sunken testa. Their alternative use as food beans generally involves a loss in profit. Investigations in the Ol Joro area of Northern Province have shown a high incidence

of bug damage on a number of bean varieties, a range of from twenty-five per cent to fifty-four per cent being recorded. Damage would appear to be proportionately higher in accordance with the greater elevation of the farm.

Laboratory tests have indicated that DDT emulsion may be effective in controlling the pests and it is hoped to organize experiments on control for the next season.

In the Kisaki District of Eastern Province similar and considerable damage to dwarf beans was reported due to another Coreid bug which has been identified as *Riptortus dentipes*, Fabr.

Survey of Crop and Insect Damage

Cereals.—Reports of heavy attacks by *Busseola fusca*, F. have been received from Mbulu, Tabora District, Lake Province generally and Masasi in Southern Province.

The first plantings made after the end of the dry season are more heavily damaged than later ones; in an attempt to reduce this damage a close season has been instituted in Lake Province during which all maize and sorghum plants are either uprooted and burned or trampled under foot in cattle bomas.

From the Central Province, where varieties of short term sorghums were being grown experimentally, it was reported that the varieties Oklahoma, Plainsman and Feterita Managil were severely infested with *Calidea dregei*, Germ. with a consequent reduction in yield. Dobbs sorghum was apparently only lightly infested by *Calidea* in these experiments; heavy infestations of *Calidea* on this variety have however been seen by the writer in the past at Lubaga in Lake Province.

The grass hopper, *Cyrtacanthacris tatarica*, L., was stated to have caused some damage to maize in the Turiani area.

Legumes.—Mention has already been made of sucking bug damage to beans in Northern and Eastern provinces. A spectacular outbreak of caterpillars of *Maruca testulalis*, Geyer, on cow-pea near Morogoro was investigated in June. After boring into the maturing pods and eating the seeds the larvæ went on in many cases to bore into the stem of the plant itself and to destroy it. From weighings made in the Morogoro laboratory it was estimated that 23·6 per cent of the seed was lost before the infestation was noticed. The field was harvested and the plants put into silage to prevent further loss.

Considerable damage was done by the Galerucid beetle, *Ootheca bennigsenni* Wse., to cow-pea in plots near the one attacked by *Maruca*. As noticed in previous seasons the damage was heavier round the periphery of the blocks than in the centre.

What appeared to be a virus yellows disease of cow-pea was noticed in a number of areas in the Kisaki District. Both Jassid, *Empoasca* sp., and white-fly, *Bemisia* sp., were abundant in the crop but it was unfortunately not possible to carry out any transmission experiments.

In the Northern Province a heavy infestation of seed beans by larvæ of *Heliothis armigera*, Hb. was reported to have been controlled on a European estate by aerial spraying with a 0·24 per cent DDT emulsion. Considerable

damage had however occurred before control measures were asked for and could be put in hand. This insect also caused local damage to lima beans in Mbeya District.

The flea beetle, *Aphthona bimaculata* Jac., was stated to have caused extensive damage to pulses in Southern Province. Sesame in the same Province was attacked by an unidentified aphid and groundnut yield severely depressed by high incidence of rosette virus of which the vector is *Aphis laburni*, Kalt.

Root Crops.—Very heavy infestations of cassava scale, *Aomidiomytilus albus* Ckll., were seen in an isolated ten-acre communal shamba at Makutopora in Central Province. Vigorous cutting back of all the plants and spraying with 0·5 per cent and 1·0 per cent DDT emulsions was carried out but was reported as not having satisfactorily controlled the infestation.

Castor.—The Capsid bug, *Helopeltis bergrothi*, Rout., again caused damage to castor in the Mpwapwa area; a Cossid stem borer, probably *Xyleutes capensis*, Wlk., was also reported from Kondoa together with unidentified leaf miners and small leaf-eating caterpillars.

Bananas.—An energetic campaign to combat the weevil, *Cosmopolites sordidus*, Germ., has been carried out in Bukoba; the results have been described as satisfactory. This pest has now been reported in South Biharamulo District for the first time.

Cotton.—An excellent crop of cotton was obtained from the Lake Province this year and the yield would have been considerably higher but for attacks by *Helopeltis bergrothi*, Reut. in areas of West Geita. Much of the damage appeared in areas adjacent to bush land, suggesting that the insect had bred up on wild hosts and then moved into the cotton. The incidence of the other usual cotton pests in Lake Province was fairly low. Little American Bollworm (*Heliothis armigera* Hb.) was experienced owing to the adverse effect of heavy rains on maize plantings. On experimental plots at Ngara stem weevil, *Apion* sp., and the capsid bug, *Lygus simoni*, Reut., appeared to be the major pests retarding growth of the plants.

In Eastern Province too, pest infestation has been generally low: local infestations of *Heliothis armigera*, Hb. up to 40,000 larvæ per acre have been obtained in the Kilosa District and between 10,000 and 12,000 per acre at Mvomero. Spiny bollworm, *Earias* sp., did some local damage towards the end of the season. Stainers, *Dysdercus* sp., have been few in number.

Miscellaneous Reports

The Kagera Dwarf Locust, *Faureia milanjica*, Karsch. reported in large numbers in Bukoba in 1950 was again present this year in Lake Province and damaged maize and beans in Geita. The insect was also recorded from Tabora District but caused no damage to crops.

The beetle, *Lasioderma sericorne*, F., was found in tobacco in Iringa. The consignment was promptly destroyed and spraying of stores with DDT wettable powder carried out after cleaning up measures had been put in hand. This insect was found in fair numbers in a proprietary cereal product from a shop in Morogoro. Larvæ of *Ephestia cautella*, Wlk. were abundant in the same shop in paper wrapped blocks of chocolate which had been in stock for some time.

Cabbage aphis, *Brevicoryne brassicae*, L., caused some damage to dry season crops at Turiani whilst, *Plutella maculipennis* Curt, and the saw fly, *Athalia sjostedti*, Kuhm., were the cause of complaints received from areas in the Uluguru mountains. DDT emulsion spraying of young plants proved effective against the two latter pests.

Hilda patruelis, Stel. was stated to be the cause of considerable damage to developing cashew nuts at Lindi. It is proposed to investigate this problem next year.

Damage to skins in the store of the Game Ranger at Morogoro was caused by larvæ and adults of *Dermestes maculatus*, Degeer. Laboratory tests with DDT dusts indicated that five per cent DDT dust in talc was effective in control.

An outbreak of *Thrips tabaci*, Lind. on onions being grown near Arusha was controlled by the application of an 0·1 per cent DDT emulsion at ten-day intervals.

The Bostrichid borer, *Apate terebreus*, Pall., was received from Singida where it was taken boring into flamboyante trees (*Poinciana regia*. Boj.). At Bunduki in the Uluguru mountains a species of *Melolontha* larva causing damage to seedlings in a Forestry Department nursery was controlled by lightly raking a 0·45 per cent gamma B.H.C. dust into the planting rows.

Additions to the List of Injurious Insects

Riptortus dentipes, Fabr.—sucking bug damage on beans.
Maruca testulalis, Wlk.—boring in pods of cow-pea.

Acknowledgments

The Director and staff of the Commonwealth Institute of Entomology have once more given valuable help with identifications of insect: their assistance is greatly appreciated.

G. Swaine,
Entomologist

ANNUAL REPORT OF THE PLANT PATHOLOGIST, 1952

Staff

The Plant Pathologist was absent on vacation leave from 17th April to 7th October. The Temporary Scientific Assistant (Mrs. M. M. Wallace) was on leave for the same period. The opportunity was taken to visit various scientific institutions in England. Mr. N. B. Joy, Plant Pathologist, has pursued studies at Cambridge and Trinidad, and is expected to arrive in the Territory at the end of 1953, on first appointment.

Acknowledgments

Grateful acknowledgment is made to the following authorities for identifications of fungi, bacteria and viruses: the Director and staff of the Commonwealth Mycological Institute, Kew, Dr. W. J. Dowson and Dr. K. M. Smith, Cambridge, and Dr. W. L. Gordon, Department of Agriculture, Winnipeg. We are much indebted to the Banana Growers' Federation Co-operative Limited in New South Wales, for information on the instrument they use for injecting bananas with hormone weed-killers, and for kindly supplying such an instrument.

Touring

Short visits were made by the Plant Pathologist to the Usambara, Pare, Tanga and Arusha areas, and by the Temporary Scientific Assistant to Tanga and Lushoto.

Publications

A short supplementary note on Bacterial blight of Pea, and articles on Panama Disease of Banana and Bole rot of Sisal (the latter in collaboration with Mr. E. C. Diekmahns) were published by the Laboratory Staff in the *East African Agricultural Journal*. There are five items still awaiting publication, including a Supplement to the Tanganyika Check List of plant diseases.

Visitors

His Excellency the Governor and party attended a demonstration of Panama disease and the control measures being undertaken. Visitors to the Laboratory included the following: Dr. F. M. L. Sheffield and Dr. R. M. Nattrass from Kenya, Mr. D. L. Downie from Uganda, Mr. W. Wendlaw from Hanover, Germany, Mr. F. L. Wellman of the Office of Foreign Agricultural Relations, U.S.A., and Mr. P. G. Sylvian, Addis Ababa.

Laboratory Work

More time has been devoted to the Panama disease of banana in the Moshi District than to any other subject. Among 168 miscellaneous plant specimens examined, nine proved to be new records of parasites in the Territory, and twelve are new hosts for fungi already known in Tanganyika. Germination tests of seed samples were made as required. Cultures of Rhizobium were maintained and thirty-three tubes supplied to growers.

Diseases dealt with during the year are mentioned below under the host plants in alphabetical order. The weather was very dry and this discouraged plant diseases very considerably.

Apple.—Canker caused by *Botryosphaeria ribis* was recorded at Lyamungu. (The Nectria canker has not been found in Tanganyika).

Banana. Panama disease or Wilt (*Fusarium oxysporum* forma *cubense*) which was first recorded in the Territory in August, 1951, in the Moshi District, has spread during 1952 to the Same (Pare) District; suspicions of the disease in the Korogwe and Muhesa areas await confirmation.

Spread of the disease has been greatly restricted, first by the dry weather of 1952, and secondly by the routine destruction of infected plants. What success we have had in controlling the disease so far is, to a large extent, due to the intensive work of the field staff, European and African, of the Department.

The control measures we have applied are: preventing the movement of infective material and the destruction of infected banana plants—chiefly by killing them with hormone weed-killers. An instrument for injecting the latter has been improvized at the laboratory. This is a sheep drenching pistol with a long nozzle made to specification at the workshops of the East African Railways at Dar es Salaam. It has proved adequate for comparatively small numbers of banana plants. For larger numbers the modified knapsack sprayer, as used in New South Wales for killing banana plants would be more expeditious. An instrument of the latter type is in the Agricultural Office in Moshi.

A knowledge of the degree of resistance or susceptibility of local banana varieties to Panama is essential. With this in mind, many local varieties are being tested on infected land. Conclusive results will not be forthcoming for perhaps two years. In the meantime observations in the banana groves show that the following three varieties are very susceptible: *kisukari kifupi* (*Kisukari kifii* in Kichagga), a small banana used for making beer; *mkojosi* (*ikonosi* in Kichagga, and *bokoboko* in the coastal areas), popular for beer-making; and the much less common variety *kisukari jivu-jivu* which like other kisukari varieties is eaten raw. A very common variety which appears so far to be immune is *kimalindi*, a cooking variety which is also eaten raw.

Demonstrations of the disease have been given by the Plant Pathologist and the Agricultural Officer and Agricultural Assistants, Moshi, to a number of parties of Africans of the Moshi and neighbouring districts; to members of the Tanganyika Department of Agriculture; and to representatives of the Kenya and Uganda Departments and of the East African Agricultural and Forestry Research Organization.

An illustrated article on the disease was published in the *East African Agricultural Journal* in April, 1952, and a Kiswahili version is being prepared for African growers.

The inevitable expenses involved in Panama control have been met, in the Moshi District, by generous allocations of funds by the Moshi Chagga Council and the Kilimanjaro Native Co-operative Union, Moshi. In other districts the local Native Authorities have also met expenses for chemicals and injecting pistols.

Other banana diseases noted during the year are as follows: Cordana leaf spot (*Cordana musae*) was found for the first time near Muhesa; *Cercospora musae* was also present. Neither was causing any obvious loss. *Curvularia lunata* turned up in cultures from rhizome tissues, but is a known saprophyte elsewhere on banana leaf spots and decaying banana tissue. *Thielaviopsis paradoxa* was also obtained in culture from rhizomes.

Beans.—French beans in the Arusha District were reported by the Agricultural Officer, Arusha, to have been little affected by disease. The bacterial leaf spot of Lima bean, queried as *Pseudomonas syringae* in 1951, has been identified by Dr. W. J. Dowson as closely corresponding to *Ps. glycinea* Coerper.

Coffee.—The cause of failure in young coffee trees at Mbosi is still under investigation. There is a rot of the collars, but no obvious parasite has been found in the tissues. A *Fusarium* sp. and a *Phomopsis* sp. were present but are probably not primary parasites.

Cotton.—Verticillium wilt or Fusarium wilt of cotton was suspected at Lubaga in the Lake Province. The plants had all the symptoms of Wilt, but neither Fusarium nor Verticillium developed in isolations made from infected plants. Dr. Wickens of the Empire Cotton Growing Corporation has also failed to isolate either of these fungi and considers that there may be some factor at Lubaga controlling the disease.

Control of Blackarm is being studied by the Chief Scientific Officer, Ukiriguru: until resistance can be bred into the desirable strains, effective control is being obtained by the use of chemical dusts.

Flowering Plants.—Leaf spots and withering of leaf tips of *Agapanthus umbellatus* were caused by *Mycosphaerella agapanthi*. *Alternaria brassicae* (Berk.) Sacc. was isolated from the stems of defoliated Candytuft and was found capable of reproducing the disease. An Aloe sp. was killed as a result of foot-rot caused by *Pythium splendens*. (Identification confirmed by Dr. V. A. Wager).

Forest Trees.—Living trees of the giant *Piptadenia buchanani* in the Usambara mountains were found infected by *Armillaria mellea*. It is therefore advisable to deal with this species before planting land with such crops as tea: the trees should be either uprooted, or be ring-barked not less than thirty months before felling and planting with tea, etc.

A further host of *A. mellea* is *Pinus taeda*.

Lucerne.—The bacteria responsible for causing a leaf spot of lucerne were queried in the 1951 Annual Report as *Pseudomonas medicaginis*. The organism has, however, been identified by Dr. W. J. Dowson as a strain of *Ps. syringae*.

Maize.—The dry year has favoured healthy crops of maize: there has been much less damage by ear-rot fungi, and this will incidentally mean healthier seed for sowing in the next season. One of the minor causes of ear rot, *Nigrospora oryzae* was observed: this fungus has previously been found on glumes of rice and on the leaves of Elephant grass.

The rust *Puccinia polysora*, which recently reached East Africa, has been recorded from the Moshi, Kilosa, Muhesa and Tanga districts, and probably has a wider distribution. So far there have been no complaints of serious loss.

Pea.- Bacterial blight (*Pseudomonas pisi*) which was already known in the Moshi and Lushoto districts was found at Iringa early in the year, and later at Mbeya. In the Southern Highlands Province the disease was observed only in the very early planted crop and not in the main crop. At the end of the year the disease was seen to be very mild in the Usambara mountains. The dry weather has favoured the crops in this respect.

Rice.—Damage by birds accounts for a condition seen in rice and not previously understood. According to Mr. N. R. Fuggles-Couchman, Agricultural Officer, when birds suck the florets when the grain is in the milk stage some of the liquid dries on the outside of the glumes, leaving a white deposit resembling fungus spores. The glumes are either empty or nearly so.

Sisal. Mr. R. C. H. Sweeney, Entomologist of Messrs. Pest Control Limited, working on sisal weevil near Tanga, distinguishes several types of bole rot depending on whether they are acceptable sites for weevil breeding or not. Some attempt has been made to determine whether different pathogenic organisms were responsible for two of these apparently different forms of bole rot. From a bole typical of those which in Mr. Sweeney's experience never become breeding sites, *Aspergillus niger* was isolated in culture. (This fungus is associated with the common wet form of bole rot). These "non-breeding" boles are yellow in colour, and have a strong alcoholic smell, but are not wet and stinking.

A second type of rot, a dark brown-black rot at the base of the spike and spreading *downwards* into the bole, distinguishable from wet bole rot, was examined as a typical "breeding-bole". Bacteria and *Fusarium solani* sensu Snyder and Hansen (kindly confirmed by Dr. W. L. Gordon) were isolated in culture from the extreme edge of the rotted area in the bole and from the centre of the base of the spike. None of these organisms was, however, capable of initiating an active rot in artificially inoculated sisal plants in the laboratory. The inference is that the weevils introduce these organisms into the boles. *F. solani* is a common soil organism and is seldom a primary cause of disease. Further investigational work remains to be done.

Sorghum. -Almost total loss in two plots of American sorghums, "Martin" and a "Shallu" cross was recorded by the Botanist at Ukiriguru. The disease present was found to be a Foot rot caused by *Fusarium moniliforme* var. *subglutinans*. *Macrophomina phaseoli* was also present. The same sub-species of Fusarium was also associated with a Foot rot of volunteer plants of sorghum in fields of the Overseas Food Corporation at Urambo.

In the Eastern Province, the Regional Assistant Director of Agriculture, Morogoro, records Asali disease (*Sphacelia sorghi*) as being the most destructive sorghum disease this year.

Tobacco. The Provincial Agricultural Officer, Iringa, reports Angular leaf spot (*Pseudomonas angulata*) as the most troublesome tobacco disease this season. Mosaic is thought to be decreasing.

Tomato. -A large proportion of plants on a four-acre field near Moshi were severely stunted by what appears to be a virus disease, the symptoms of which have not been correlated with any of the known virus diseases of this crop.

Tree-tomato.—There are two virus diseases of this tree in the Territory; tobacco Rosette in the Northern Province, and a second near Mbeya. The latter was briefly described in *Mycological Circular* No. 31, and has since been identified by Dr. K. M. Smith as a new virus disease which he names "Mbeya Mottle". This virus differs from the mottling component of the Rosette complex. The danger of growing tree tomato near tobacco has been brought to the attention of growers.

Wheat.—In the Southern Highlands Province as a whole Rusts of wheat were not serious, but certain varieties (e.g. "K.G.", "Reward" and some plantings of "294") were badly affected in the Iringa District. The cause of a partial failure of "Kenya Settler" at Dabaga is uncertain.

The Agricultural Officer (Experiments), Iringa, provides the following further information. A form of Foot rot was found to an insignificant extent in wheat trials. Leaf rust which is always present had no apparent effect on the growth of the plants or on the grain. Yellow rust, which occurred in most varieties with insignificant effect, was severe in the Kenya variety 294M7C6A in one trial.

Stem rust was present in the Iringa wheat, especially in the trials at Dabaga: there was little at Sao Hill, Mufindi and Mbozi, and it was absent from Njiapanda, Uyole and the Poroto mountains. The degree of severity of stem rust was noted in many wheat varieties at Iringa, they varied from nil to almost complete loss of crop. Kenya Governor was the most severely affected, closely followed by Reward, Kenya Ploughman and 294M7C6A; Kenya Settler and 294B2A3 had infection which varied with locality. The variety 44/W/34 was affected in some areas only while in B192Q2AL the rust was late and caused no damage. In the following varieties infection was slight to only a trace or absent: 261S10C2D, 291J1I1, Regent 9756, 337BE2F2, 338AA1A2 and 360H.

Information on wheat diseases in the Northern Province has been obtained from a report by the Senior Plant Breeder, Njoro, who inspected the wheat areas in July. Disease is reported not to have been a factor causing appreciable loss in yield, and 1952 could not be called a rust year. Stem rust, *P. graminis*, was fairly widespread throughout the wheat belt but it had come mostly too late to cause more than slight damage. Identification of Stem rust forms had been made by favour of the Senior Plant Pathologist, Nairobi; these proved to be mostly the forms K9 and K11; K1 and K6 were less common. Mr. Thorpe reports that farmers are increasingly turning over to newer and more rust-resistant wheats and abandoning the older susceptible varieties.

A certain amount of leaf-rust, *P. triticina*, was observed, particularly in the lower areas, but was not considered to have caused any appreciable damage. Little Yellow rust, *P. glumarum*, was seen and this was thought to be partially due to the fact that growers are keeping susceptible varieties to their recommended altitudes. Helminthosporium and Septoria on the foliage were fairly widespread especially in the higher and wetter areas; they caused considerable die-back of the lower foliage, but did not seem to cause any serious reduction in yield.

The following pathogens are recorded in Tanganyika for the first time:—

Botryosphaeria ribis Grossenb. & Duggar on apple.
Cordana musae (Zimm.) von Hohn. on banana.

Curvularia lunata (Wakker) Boedijn on banana.
Fusarium solani (Mart.) App. & Wr. on sisal.
Mycosphaerella agapanthi (Kalchbr. & Cooke) Lindau on *Agapanthus unbellatus*.
Pseudomonas syringae van Hall on lucerne*.
Pseudomonas glycinea Coerper on Lima bean*.
Puccinia polysora Underw. on maize.
Pythium ?splendens Braun on *Aloe* sp.
New hosts for pathogens already recorded in Tanganyika:—
Candytuft, *Alternaria brassicae* (Berk.) Sacc.
Fig, *Glomerella cingulata* (Stonem.) Spauld. & Schrenk.
Maize ear rot, *Nigrospora oryzae* (Berk. & Br.) Petch.
Panicum miliaceum, *Fusarium moniliforme* Sheld. var. *subglutinans* Wr. & Rkg.
Pepino (*Solanum muricatum*), *Glomerella cingulata*.
Pepino (*Solanum muricatum*), *Myrothecium roridum* Tode ex Fr.
Pinus taeda, *Armillaria mellea* (Fr.) Quel.
Piptadenia buchanani, *Armillaria mellea*.
Sorghum, *Fusarium moniliforme* var. *subglutinans*.
Sorghum, *Macrophomina phaseoli* (Maubl.) Ashby.
Sorghum arundinaceum, Smut, *Sphacelotheca holci* Jacks.
Sorghum arundinaceum, Head smut, *Sphacelotheca reilianu* (Kuhn) Clint.

*Corrects identifications in 1951 Annual Report.

G. B. Wallace,
Plant Pathologist

BOTANIST'S ANNUAL REPORT—1951-52 SEASON

Weather

The season was the wettest yet recorded. The November, 1951, Mbuga plantings were washed away, and work was confined to the hill land. Rainfall was insufficient for proper germination of the October to November, 1952 plantings.

Sorghum Breeding

General.—The object of the breeding programme is to obtain early maturing Sorghums with palatable grains, which store well and yield well. Resistance to birds, to grain smut, and to *Striga hermonthica* are also included, together with the transfer of a large grain on to early maturing types. The programme may be summarized as an attempt to obtain sorghum varieties which cultivators will desire to grow in place of maize, in areas where the latter crop is unreliable.

Straightforward selection has yielded disappointing results, and a large programme of hybridization is in hand.

Storage.—It is now clear that there are three main forms of damage to sorghum grain to be considered.

(1) Damage in store by the Weevil-*Tribolium* combination.

(2) Damage in the field, and to some extent in store, by grain moths. (*Sitrotroga cereallela*).

(3) Damage in the field by grain moulds (mainly *Alternaria tenuis* and *Fusarium* sp.). The moulds render the grain more susceptible to insect damage.

Satisfactory evidence has been obtained showing that grains of different sorghum varieties are attacked by weevils at very different rates, and that a thick corneous layer in the endosperm is correlated with a slow rate of attack. A paper on this is in preparation. It is now possible to select in the field heads with grain which will stand up well to weevil attack, and breeding for this character is accordingly simplified.

Differences in the damage done by grain moth certainly exist, but grain characters giving resistance to the moth have not yet been identified.

Susceptibility to grain mould also varies very much between sorghum varieties.

Hybridization.—Varieties used as the early maturing parents are B.C. 27 White (three and a half months, poor storer), Dobbs (four and a half months, poor storer), Oklahoma 44/14 and Martin (American combine types). Desired characters are being transferred to these varieties, as follows:—

(A) *Weevil Resistant Grain.*—Crosses have been made as follows:—

B.C. 27 × Wiru (Late maturing, grain resistant to weevil).

Early maturing plants with weevil resistant grains segregated in the F_2, but heads were poor. An F_3 generation was grown in the dry season from the best of them, and the F_4 generation of these, together with the F_3 of the remainder, was planted in October. These are represented by some 18,000 plants.

B.C. 27 × (B.C. 27 × Wiru). The first backcross generation was grown, and gave quite vigorous plants. Forty thousand plants of the F_2 generation of the first backcross were planted in October, and some of these show promise. The first backcross was repeated, using early maturing hard-grained segregates from the F_2 of the main cross, and this material is now being used to make the second backcross.

An F_2 generation of 7,000 plants from the cross Dobbs × Wiru was planted in October, together with the F_1 of the first backcross Dobbs × (Dobbs × Wiru). Early maturing plants with weevil resistant grain should be segregating. Seven thousand plants from the F_2 generations of the crosses Martin × Wiru, Oklahoma × Wiru, and Martin × (Oklahoma × Wiru) have also been planted, together with the first backcross generations of Martin × (Martin × Wiru) and Oklahoma × (Oklahoma × Wiru).

Five other parents which have a grain which stores well, and which in addition may be resistant to both grain moth and grain mould are Msumbiji, Ushiriki, Nokwe, Wiru ex Ugogo, and Belko. The latter has relatively long awns, (14 mm.), which may be of some assistance against birds. From these, the crosses B.C. 27 × Msumbiji, B.C. 27 × Nokwe, and B.C. 27 × Belko have been completed, and a total of some 3,000 plants from the F_2 generations are planted, together with the F_1 of the first backcross generation to the B.C. parent. In addition, the crosses Dobbs × Belko, and Dobbs × Ushiriki have been made, and the F_2 planted. Material segregating from crosses of (B.C. × Wiru) × (B.C. × D.D. Shallu) and (B.C. × Wiru) × (Dobbs × D.D. Shallu) is showing some promise. Study of the behaviour of these crosses indicates that it is merely a matter of time before early maturing sorghums combining good yield with desirable grain characters are obtained, and definite progress towards attaining that objective has been made.

Birds.—The problem of bird damage is the most difficult of those to be solved by breeding. The breeder's object must be to incorporate as many characters as possible which are likely to lessen bird damage. In many cases *Quelea* do the most damage, as a concentrated attack, but the larger weaver birds, pigeons, parakeets, and even Kavirondo cranes can do a great deal of damage through the season.

Characters which may be of some use are as follows:—

(a) *Earliness of Maturity.*—*Quelea* damage can be avoided by planting early maturing varieties early in the season: these birds will not take the grain once it has hardened. At Lubaga this year a large plot of Shallu had hardened its grain before the invasion of *Quelea* took place, and although it has a most palatable grain and is easily attacked by birds, there was no bird damage. A neighbouring plot of Nyanza, a very bitter, late sorghum, had its grain in the milky stage when the *Quelea* arrived, and was completely stripped.

At Ukiriguru, the Shallu was stripped in the milky stage by the local population of small grain-eating birds which included some *Quelea* from scrub on the kopjes, long before the large flocks of *Quelea* had been observed feeding.

It is very probable that the planting of early maturing sorghums at the beginning of the season where the countryside is open will avoid bird damage by ripening before the flocks of *Quelea* form, or arrive. Where the countryside has a good deal of bush and scrub supporting grain-eating birds, earliness of maturity is of no benefit whatever.

(b) *Height.*—Bird scaring is difficult in tall sorghums: double dwarf sorghums are eaten as they stand by birds such as Kavirondo cranes. For peasant cultivation a height of four feet to five feet appears to be best, and both Dobbs and B.C. 27 White are of a suitable height.

(c) *Panicle Type.*—At Ukiriguru, a compact, inverted head ("goose neck") suffers far less bird damage than other types, the grain on the lower part of the panicle escaping damage. Ng'hollongo is a local, late maturing variety of this type, and crosses have been made as follows:—

B.C. 27 × Ng'hollongo, Dobbs × Ng'hollongo, Oklahoma 44/14 × Ng'hollongo. Four thousand plants of the F_2 generations have been planted from these crosses, together with the F_1 of the first backcross to the early maturing parent. A very dense panicle will be of no use ripening under wet conditions, but a Jowar from India (Nandayal Poona) has very short, stiff branches giving a compact, well ventilated panicle.

Two thousand plants of the F_2 generation from the cross B.C. 27 × Nandayal Poona have been planted, together with the first backcross of B.C. 27 × (B.C. 27 × Nandayal Poona), and the F_1 of the cross Dobbs × Nandayal Poona.

(d) *Awns.*—It is doubtful whether sorghum awns can ever do more than render the heads slightly less attractive to birds. Both Belko and Nandayal Poona have relatively long awns, and the crosses made with these have been recorded above. Korgi from the Sudan has much enlarged floral parts, and the cross Korgi × Belko has been made in the hopes of obtaining a longer and stronger awn.

(e) *Grain.*—Bitter grains are less liable to bird damage than sweet ones, but this is entirely a matter of preferential feeding. Two varieties of sorghum from the U.S.A., the grain of which is astringent when immature, but palatable when ripe, have been planted for crossing.

(B) *Large Grains.*—The variety "Korgi" from the Sudan has a grain which is from two to four times the size of the local grains. This grain can be handled very much like maize for the preparation of food and Africans who visit the Station are very enthusiastic about it. Apart from the fact that the transfer of a large grain may increase yield, it should prove to be an important "selling point" in those marginal areas where it is hoped to reverse the tendency to replace sorghum by maize. The large grain is dominant, which allows of a more rapid transfer. The F_1 generation of the second backcross of B.C. 27 × Korgi, Dobbs × Korgi, and Oklahoma × Korgi has been planted, and from six to eight lines are being carried up as there is likely to be more than one gene affecting grain size. The F_2 generations from the first cross and first backcross have also been planted.

(D) *Grain Smut.*—The local variety of Ng'hollongo appears to be very smut resistant. Separate smut-infected F_2 generations of B.C. 27 × Ng'hollongo and Oklahoma × Ng'hollongo have been planted. There was insufficient material from the Dobbs × Ng'hollongo cross to allow of this being included.

General.—The following up of the above hybridization programme along conventional lines is evidently far beyond the abilities of one person to perform. It is intended to concentrate on a few of the more promising crosses, and to mix up the first backcross material from the remainder as bulks. This will form a reservoir of early maturing sorghums with a wide range of important characters, from which material can be taken as required. It will also be of great value when the contribution which breeding work on sorghum can make has been more widely appreciated.

Striga.—Variety trials continue to show that important differences in susceptibility to Striga hermonthica exist. Figures from the Mabuki plot illustrate this.

Mabuki Plot

Variety	1950 No. of Striga plants	1950 Grain yield lb./acre	1951 No. of Striga plants	1951 Grain yield lb./acre	1952 No. of Striga plants	1952 Grain yield lb./acre	Total Striga plants 1950-52
P.41	237	190	266	1,630	1,285	450	1,788
Dobbs	74	750	218	1,190	1,107	280	1,399
Bukura Mahemba ...	1,658	1,235	1,166	508	7,943	155	10,767
Ng'hollongo ...	5,933	1,315	3,944	131	9,366	43	19,243

The following is a summary over eight district plots for the period 1950-52: (Results were not obtained from all the plots each year). The trial at each plot was a randomized block layout, with six replications each season.

Variety	Total Striga	Mean Striga per trial	Mean yield of grain lb./acre
P.41	3,877	277=106	511=141
Dobbs	4,245	303=123	947=158
B. Mahemba ...	22,837	1,631=587	715=158
Ng'hollongo ...	33,539	2,396=736	383=159

Doing a logarithmic transformation on the Striga counts, treating each place in each season as a separate block (ignoring the replication within the trials), the following figures are obtained:—

Log Striga Total

P.41	25·76	
Dobbs	26·58	Sig. Diff. ·05=4·09
B. Mahemba ...	39·60	·01=5·57
Ng'hollongo ...	43·33	

The difference between P. 41, and Dobbs and Bukura Mahemba, and Ng'hollongo is therefore highly significant.

The yield figures show that the lower numbers of striga plants on Dobbs cannot be due to the Striga so weakening the sorghum plants that only few of the witchweed appear above ground. These results over three seasons and a wide scatter of places make it fairly certain that Dobbs possesses a degree of Striga resistance. Selection work within Dobbs is being continued on land heavily infested with Striga seed, and any more resistant types obtained will be used as the recurring parents for the Dobbs crosses in the breeding programme.

The traditional Striga trial here has clearly demonstrated that if all Striga plants are uprooted each season before they have flowered, the land can be cleaned of the witchweed. Counts made in the district plots show that this task must defeat most African cultivators. The soils of the district plots are certainly no more heavily infested with Striga seed than the surrounding African fields, and counts show an average number* of 57,000 and 31,000 Striga plants per acre on Ng'hollongo and Bukura Mahemba, both popular local varieties of sorghum. Striga resistant varieties of sorghum would reduce the task of uprooting to more manageable proportions, but it would still be necessary to try to reduce the reservoir of Striga seed in the soil. A small observation trial with 2:4 D yielded inconclusive results, and will be repeated, but both herbicides and trap cropping are beyond the ability of the peasant to apply himself. Crop rotation offers better prospects, and a rotation trial has gone down to its first year under gram, cotton, sunflower and velvet beans, having previously been under sorghum for two seasons, sown with Striga. Some indication that cotton may reduce the amount of Striga is given by counts on a rotation trial at Lubaga, cotton alternate years with Dobbs sorghum, as against continuous Dobbs. (Counts were done this season, the 10th, only):—

6 Replications.

	Mean No. of Striga plants per acre
Dobbs following Cotton	1,160
Continuous Dobbs	4,010

The Dobbs following cotton has significantly less Striga at $P = \cdot 01$.

Introduction and Reference Collection.—Two hundred and eight sorghum varieties, and ninety-four introductions from the O.F.C. were grown. Over one hundred and fifty introductions were received during the year, and were planted in November. Many people have been most helpful in supplying seed, and correspondence has been carried on with Dr. Karper of Lubbock, Texas, who has taken a great interest in the work.

It would be desirable to maintain all the sorghum varieties received as a reference collection, but the amount of work which is involved in keeping them as separate varieties is quite beyond the facilities available. Many have to be discarded, and it may be necessary to mix the remainder as general bulk and allow them to open pollinate. This would mean that their characters would be retained for future use in breeding work, but that the varieties themselves would disappear.

Rice

General.—The heavy rains at the beginning of the 1951-52 season delayed sowing, as the seed beds were under water. During the dry season, the channel from the Lake to the pump-house was cleaned out, and the main concrete irrigation furrow was re-laid with a fall of three inches per one hundred feet. Very dry conditions prevailed at the end of 1952, but it was possible to cultivate and sow the seed beds in good time by using the pump.

*The Striga infestation in the district plots is light, and the yield figures quoted above bear no relation to the number of Striga plants present; they do indicate that these sorghum varieties are capable of carrying an appreciable Striga population without much loss of yield. The traditional Striga trial here with Bukura Mahemba showed mean yields of 596 lb./acre against 62 lb./acre over three seasons on the Striga free and Striga infested plots. The numbers of Striga plants per acre in this trial must be astronomical, but many fields approach the same degree of infestation.

Rice Improvement.—The evidence shows clearly that a controlled water supply is the prime consideration in raising rice yields. Many of the local rices are potentially very good yielders; the increment in yield to be obtained by plant breeding and refinement of cultural practices, is very small by comparison with the great increases of yield which will be obtained when water supplies are controlled. With only one Plant Breeder to work on the food crops here, there can be no doubt that the rice work should be regarded as of less importance than the sorghum breeding work. The work has therefore been confined to straightforward selection, and filtering through variety trials, together with the providing of pure seed stocks.

Selection Work.—The aim of the selection work is to obtain rice varieties which are superior to Kahogo in straw strength and shedding, with a yield and quality which are at least as good.

Four hundred and thirty-seven selections and re-selections made in 1951 were grown out in progeny rows. Four hundred and forty-one re-selections were made from these, and from varietal bulks. Many of the 1951 selections were discarded, but sixty-seven of those which appeared to be uniform and vigorous were selected for trial, and graded on straw strength, shedding, grain quality, and yield, as follows:—

	Selections
Good straw strength	61
Non-shedding	21
Good quality	28
Good yield	35

Some of the best material came from Gamti, Afaa Mwanza, Afaa Kilombero, and Shindano.

These have been sown together with the best of the 1950 selections for 169 strain sextuple lattice trial. Quite apart from any statistical considerations, the replication and randomization in such a lay-out allow of much better assessment of field characters and yield than can be obtained from single progeny rows.

The best strains from the 1950 trials have been sown for a twenty-five strain variety trial, with Kahogo and Afaa Mwanza as controls.

Owing to the Botanist's absence on leave, no trials were done last season, and quite a lot of material was not sown. More than 1,000 selections have therefore had to go in for the 1952-53 season.

There is plenty of variability in the material at Mwabagole, and there is every indication that the selection work is yielding results, although the evidence of further trials is required to confirm this.

Cassava

General.—Attention is given to cassava as opportunity allows: the varieties from Amani continue to show better yield and a much higher degree of mosaic resistance than the local Kalagala. They are damaged by porcupine, and periodical campaigns against these vermin have to be conducted.

Trials.—The results of a variety trial are given below:—

	Planted 11.2.50		Harvested 25-26.7.52			
Variety	*Yield in 1000 lb./ acre*	*Stand (% of mean stand)*	*% of plants with mosaic; and intensity of disease*			
			Heavy	*Medium*	*Light*	*None*
Liongo (Tabora local)	28·5	112	56%	6·5%	—	37·5
Msitu Zanzibar	18·7	92	7	67	—	26
Ukerewe	12·1	85	—	55	20	25
4026/16 (Amani Variety)	12·0	101	—	4	73	23
4026/4 (Amani Variety)	11·6	100	1	21	62	17
4026/20 (Amani Variety)	10·8	98	—	27	53	20
4029/11 (Amani Variety)	8·5	114	—	66	—	34
405/1 (Amani Variety)	7·5	95	—	55	20	25
Kalagala (local control)	2·1	102	100	—	—	Nil

The mean stand was seventy-one per cent of the original planting.

These results correspond reasonably well with those obtained in the 1950 trial.

Other Amani material (raised from seed) has been sorted, and twenty-five hopeful clones will be planted in a trial. Some of these appear to make rapid growth, and to yield early.

Multiplication. Several thousand cassava cuttings were made available during the year for planting up multiplication plots in the Province. Some modification of this policy is necessary: large areas of cassava on the station cannot receive proper attention, with the result that cassava scale has not yet been eliminated, and the material is not properly rogued for mosaic. The area of cassava bulks will be much reduced next season to a size which can be properly tended, so that small quantities of good material are available for bulking elsewhere.

Acknowledgments

Many members of the Department have been most helpful in supplying information and seed. Visits from Officers on the field side of the work have been especially useful, as their knowledge of what is really needed helps to ensure that the breeding programme is aiming at the right objectives.

Dr. Hutchinson, Mr. Peat, and Mr. Munro, of the Empire Cotton Growing Corporation, have been an unfailing source of help and encouragement in the work.

H. Doggett,
Botanist

ANNUAL REPORT OF THE FISHERIES OFFICER (INLAND FISHERIES), 1952

The forty-five-foot M.V. *Sangala* was commissioned on Lake Tanganyika on April 22nd. It has subsequently steamed nearly 2,000 miles and has been mainly engaged in a programme of fishing experiments in the area between Bangwe Point and Kabogo Head.

Dr. C. F. Hickling, C.M.G., Fisheries Adviser to the Secretary of State, visited Kigoma in March and, in company with the Fisheries Officer, made a tour of fisheries and fish farming projects in the Western and Southern Highlands provinces.

Miss R. H. Lowe and Mr. P. H. Greenwood, Fisheries Research Officers of the East African Fisheries Research Organization, Jinja, spent the months of August and September working from our Kigoma laboratory. They completed a large programme of investigations, mainly in the Malagarasi Swamps.

In May, Mr. Lockley represented the Territory at a meeting of the East African Inland Fisheries Research Advisory Committee at Jinja.

Close collaboration has been maintained with the Marine Fisheries Section of the Department and, in conjunction with the Marine Fisheries Officer and the Master Fisherman, it has been possible to use M.V. *Sangala* for testing gear and for training the crew of the Department's coast vessel M.V. *Patoni*.

Advisory work continues unabated and many extra queries were handled this year during the absence on vacation leave of the Fisheries Officer (Fish Farming).

Lake Tanganyika

The Lake Tanganyika dagaa industry has enjoyed a prosperous year although there were signs at the end of the year of a fall in prices and a slackening in demand for this commodity both in the Territory and in the Belgian Congo. This may possibly reflect the general economic situation as the main markets are with large-scale employers of fed labour. Known exports of dried dagaa via Kigoma amounted to 1,186 tons (see Appendix A) which is slightly less than last year (1,214 tons). There has been however, an increasing tendency to export away from the lake by other routes, e.g. via Mpanda, of which there are no complete records. Taking into account the considerable stocks held by Kigoma merchants at the end of the year, overall production has been not less than 1,500 tons (dried) of an approximate value of £150,000. Valuation for Customs of dried dagaa exported to ports in Belgian territory was £45,345.

Dagaa landings have been particularly heavy this year at the southern lake ports of the Ufipa District. It is gratifying to report that, after an absence of two years, the E.A.R. and H. steamer *Liemba* recommenced service in December and was able to clear a large proportion of the dried dagaa awaiting shipment to Kigoma from southern ports.

The special wood fuel ("mwenge"), used for the flares which attract and concentrate the dagaa shoals, has remained an expensive item in the fisherman's equipment. In a search for possible substitutes, experiments were conducted with a variety of acetylene flares, electric lamps and oil-pressure lamps. These met with varying degrees of technical success, the acetylene flares proving the most promising, but there is a marked lack of enthusiasm amongst the dagaa fishermen for a change from their established practice.

There is, however, a real demand for a more satisfactory type of fine-meshed netting than the mosquito netting at present used. This question was taken up with net importers and manufacturers and a number of samples tested. As a result, a new type of dagaa net should be on sale in Kigoma in 1953.

With the continuance of good catches and high prices in the dagaa fishery, fishing for other species has remained mainly at subsistence level. Fresh fish supplies in the heavily populated Kigoma–Ujiji area are still inadequate and an increase in the controlled price for fresh fish in this area did not stimulate any extra fishing effort.

In areas south of Kigoma, beyond reach of the fresh fish markets, there is a scattered seine net fishery which is producing a good quality smoked fish prepared from several species. This product finds a ready sale in inland markets and there was a small export to the Congo of nine and a half tons valued at £1,225.

The extension work of the Department continues to stress the gill net as a simple, cheap and efficient method of exploiting the stocks of larger fish and there has been a slow but steady increase in the use of this gear. This had been helped by a considerable improvement in the supplies of nets for sale from Kigoma retailers. It is noteworthy to record that many of the cheaper nets available are of Japanese, German or Italian origin.

Experimental work on Lake Tanganyika (including the Malagarasi) has taken the following lines: (a) the trial of various types of fishing gear with an emphasis on those most likely to be adapted for use in the native fisheries; (b) the exploration of existing or potential fishing grounds in an attempt to establish those factors, e.g. type of bottom, depth of water, degree of exposure, etc., which provide favourable habitats for the various economic species and to discover if there are fishing grounds or stocks of fish hitherto unexploited; (c) regular observations designed to ascertain seasonal and other fluctuations in fish populations at certain points; (d) an examination of fish catches to ascertain types of food utilized, state of breeding, etc.

Fishing experiments have been mainly conducted with trammel nets of three-inch mesh lint and nine-inch mesh armouring and with gill nets of various size meshes. Trammel nets made fairly good catches but the relatively high cost of these nets and the special skill required for fixing and repairing them, does not justify recommending their use when a fleet of gill nets of various size meshes, making as good or better catches, can be obtained for the same price and are simpler in operation. One disadvantage of the trammel net in African freshwater is the large variety of "spiny" fish which are caught which renders the clearing of this type of net a very laborious task. Trammels also entangle a disproportionately large number of freshwater crabs for which no use has yet been found, other than as bait.

Gill nets of two-inch, two and a half-inch, three-inch, four-inch, five-inch, six-inch and eight-inch meshes have been fished in a variety of situations in water up to thirty fathoms deep. Consistently better results were obtained with all size meshes when the nets were set on the bottom rather than at the surface or in mid-water. The large mesh nets, particularly the eight-inch which are in innovation on this lake, were found particularly effective for capturing the larger species of Catfish (*Chrysichthys* spp. and *Synodontis* spp.) and the Moonfish (*Citharinus gibbosus*). On one occasion twenty-six Moonfish totalling eighty-three lb. were caught in an eight-inch net of 50×2 yards. Of the smaller size meshes the three-inch gave the best results as far as total weight of fish was concerned. Nets of three-inch and below when set in certain localities, catch a large number of immature Nile Perch or Sangala (*Lates* spp.) but it is not considered necessary to place any restrictions on the use of these nets at this stage as the abundant stocks of *Lates*, which are predaceous on the dagaa shoals, are at present relatively uncropped. A nylon gill net of two and a half-inch mesh was found to have a higher catching power than similar size nets of flax or cotton and to have much greater wearing qualities. These nets are not yet on the general market and it remains to be seen whether their obvious advantages will outweigh the high prices at present ruling for nylon netting.

A large type of trap, known as the "bubu" trap on the West African coast where it has been highly successful, was built here on specifications supplied by the Fisheries Adviser. It has been tried at various depths and on various types of bottom and whilst it has caught some fish it cannot be considered a success on Lake Tanganyika. Small metal eel traps were set in shallow water amongst reeds, etc., to obtain live fish for various scientific purposes or for stocking. On occasion very good catches of a variety of species were obtained but this type of trap scarcely has any commercial application. Fyke nets, which proved very successful in the rivers gave very poor results when tried in shallow inshore areas of the Lake.

Trolling, a method which has long been used by European sport fishermen on the lake and which is a successful commercial method elsewhere, e.g. in the tuna and salmon fisheries, has considerable possibilities. Native fishermen eagerly buy up the few consignments of spoons (Swahili = "kimeremeta") which reach Kigoma. The types of lure produced by tackle manufacturers are legion. Tests have been made with a number of these (of the less exotic kind) and it has been concluded that, if the fish are present and biting, almost any kind of spinning and flashing lure will suffice. There is however, some reason to believe that the Yellowbelly or Kuhe (*Boulengerochromis microlepis*) is particularly attracted by the colour red.

Test seine hauls on suitable beaches using a net of one and a half-inch mesh' 100 yards long when mounted, have definitely established that better results are obtained by night than by day. Twilight and dawn hauls are particularly effective in certain localities. The native seines were invariably made of thread picked from the canvas of old tyres but there is an increasing tendency to use rayon, rather than cotton, thread in the manufacture of tyres. This rayon thread or "kamba sufi" is not suitable for net-making. Local retailers are now being encouraged to stock manufactured cotton seine-twines and there has been a ready sale for these.

Trawling experiments were started in December with the assistance of Mr. K. Stather, Master Fisherman. This work was largely designed to make necessary adjustments to gear and to train crews; it is premature to give a verdict as to the commercial possibilities of trawling on Lake Tanganyika. Vigneron-Dahl rig was used with a thirty-three foot headline trawl, seven fathoms sweeps and 3 feet 6 inches × 1 foot 10 inches otter boards. *Sangala* has no power winch and it was found that twenty fathoms was about the limit of depth from which the gear could be efficiently hand hauled. The lake is uncharted inshore of the fifty-metre line and it was found necessary to sound continually with the lead-line to avoid the sudden changes of depth encountered when towing. An echo-sounder would appear to be a necessity if trawling on any scale were contemplated. Trawling on Lake Tanganyika is only possible in inshore areas owing to the great depths occurring over the major part of the lake.

The trials were conducted within a thirty-mile radius of Kigoma, both by day and by night, on a variety of bottoms and in various depths from four to twenty-five fathoms. In a series of forty one-hour or two-hour tows, results varied from blank to forty pounds fish per tow. The best day yielded only 200 lb. fish for twelve hours fishing. Catches in most instances were comprised of many different species and no obvious shoals of any one species were found in the areas worked. The trawl does seem effective in catching such bottom-feeders as *Chrysichthys* and *Malapterurus*. It also caught a number of Nile Perch or Sangala (*Lates* spp.) of over ten pounds in weight. These larger *Lates* are rarely caught by other means, unfortunately they are usually solitary and hence could scarcely justify a trawl fishery.

In the course of experimental fishing operations, two rich fishing grounds, which are largely untouched by native fishermen, have been discovered. One is the large area of relatively shallow water lying off the delta of the Malagarasi with a bottom of alluvial mud, the other is in the sheltered waters of Edith Bay with a bottom of sand and rock. Whilst the former ground has yielded good catches of Catfish of several species and of other types of fish associated with muddy bottoms, both grounds, but particularly Edith Bay, have proved very productive for Nile Perch or Sangala (*Lates* spp.). An examination of many *Lates* stomachs shows that these fish are largely feeding on the dagaa shoals. The dagaa (*Stolothrissa tanganicae*) are zooplankton feeders and the shoals are most likely to occur in sheltered areas. Native dagaa fishermen do not frequent either of these grounds (although dagaa are present) and *Lates* and other predators are able to feed undisturbed.

Gill nets set off open and exposed beaches and off precipitous and rocky shores, have proved relatively unproductive. The actual rocks themselves seem to support quite a large and varied fish population whose basic link in the food-chain is the encrusting algæ of the rocks. Fishing amongst the rocks is fraught with danger both to navigation and to the fishing gear but it is in such areas that the best trolling catches, particularly of the Yellowbelly, are usually made.

The very large number of young *Lates* in the length range twelve to eighteen inches seen this year suggests that there has been an exceptionally good brood-survival year for at least one species (apparently *L. microlepis*). Although nothing is known of the growth-rates or survival age of these fish there is every reason to believe that the presence of this year-class should lead to good fishing for this species for several years to come.

An interesting addition to the fish fauna of Lake Tanganyika discovered this year, is the freshwater Puffer Fish *Tetrodon mbu*, hitherto not known east of the Congo River system. It occurs in a very restricted area off the Malagarasi Delta. This fish is poisonous if eaten and, as far as I am aware, is the first species of fish with poisonous flesh to be recorded from East African freshwaters (related species, which are also poisonous, occur off our sea coasts). This fish and its poisonous properties are known to natives living in the area where it is known as "kakamsi".

The Malagarasi

The exceptionally heavy and prolonged rains of the 1951-1952 season affected the native fishery in the Nguruka-Usinge area of the Malagarasi Swamps The swamps were a wilderness of partly submerged vegetation for well into the dry season; the fish, particularly the *Tilapia* which are the mainstay of the fishery, were widely dispersed; many fishermen were cut off from their communications with the Central Line markets and in some instances fishing camps were inundated. With the subsidence of the flood waters, heavy catches were made and a considerable quantity of smoked fish has again been marketed throughout the Territory. The scattered nature of the fishing camps, combined with the unreliability of certain African Station Masters in submitting produce returns, makes it exceedingly difficult to gauge the output of this fishery which in a normal year exports at least 200 tons of smoked fish.

The European company established at Katare is dependent on native caught fish and was accordingly affected by the floods. Through continual delays in the delivery of the equipment from the United Kingdom, this firm were still not able to install the proposed freezing plant. They have maintained a limited supply of fresh *Tilapia* to Kigoma and Tabora by passenger train without the aid of refrigeration. At the end of the year another European concern was evincing an interest in starting a fish business in the Ugalla swamp system south of the Central Line at Nguruka.

Investigations on the fish stocks of the Malagarasi System have continued and we are now in the position where we have a very reasonable knowledge of both the various species of fish and of their relative abundance in both the swamps and the open river. In this vast and largely unexplored region of waterways whose fish fauna was almost entirely unknown three years ago, the Territory has one of the richest unexploited stocks of fish in East Africa. It has remained unexploited because of the difficult and unhealthy nature of the terrain, the exceedingly sparse population and hence a lack of communications. No sensational fisheries developments can be expected yet nor should they be attempted by those not familiar with all the difficulties of the area. The fish stocks are there as and when the Malagarasi is opened up in the normal course of development.

Data collected by the Fisheries Officer in the Malagarasi have aroused considerable interest elsewhere and, in August and September, Miss R. H. Lowe and Mr. P. H. Greenwood, Fisheries Research Officers of the East African Fisheries Research Organization at Jinja, undertook investigations in the swamps and open river with the assistance of the Fisheries Officer. A considerable amount of field work was completed, several thousand *Tilapia* from the native fishery were examined and a large collection of fish and other material

was obtained for further study at the Jinja Laboratory. Miss Lowe was able to make many valuable direct observations on the breeding of the *Tilapia*. Mr. Greenwood investigated the role of *Haplochromis* in this fishery and has absolved the Malagarasi species of the charge of preying on *Tilapia* eggs and fry. During these investigations, several new species and at least one new genus of fish were discovered. Parallel investigations in another affluent river of Lake Tanganyika, the Luiche, revealed the presence of species of fish hitherto thought to be confined to the Malagarasi. During the course of this work opportunity was taken to acquire material required by other scientific workers including a collection of water plants for use in the preparation of "The Flora of Tropical East Africa".

Experimental gill netting in various localities continues to yield rich results. It can be recorded that gill nets of all size meshes, set in the usual fashion overnight, whilst making good catches of other species, catch very few *Tilapia*. The native fishery uses gill nets as splash-nets, that is they are laid by day and the fish are driven into them by beating the water. It is thus possible to fish for *Tilapia* by day and to set the same nets for other species by night and several of the more enterprising fishermen are now doing this in the Katare region. Opportunity for night sets of gill nets in the Katare swamps are now very favourable as most of the crocodiles (the principle hazard to gill nets) have now been shot out.

This year gill nets of only two-inch mesh have been tried in the swamp areas. They were found to be very heavy catchers, particularly of the smaller species of fish not caught by any other means. Conversely they were found to catch scarcely any immature *Tilapia*. A series of nine sets of two-inch nets in August yielded a total of 864 fish (average 96 per set). Only 1 young *Tilapia nilotica* and 11 young *T. karomo* were caught as against 341 *Alestes imberi*, 83 *A. macrophthalmus*, 154 *Distichodus* sp., 111 *Schilbe mystus* and 57 *Labeo* sp.—the remainder of the catches consisting of various small species of Mormyridae. The introduction of two-inch mesh nets to the native fishery can do little, if any, harm to the *Tilapia* stocks, on the contrary they can remove considerable quantities of predators such as *Schilbe* and possible competitors for the *Tilapia* food supplies such as *Distichodus*.

The remarks on trammel nets are also true for the Malagarasi. This gear can yield surprises however, e.g. a Catfish of the species *Heterobranchus longifilis*, four and a half feet in length and weighing fifty-five and a half pounds was meshed at Katare on 28th August.

A further innovation was the successful trial of fyke nets in open river stretches of the Malagarasi at Uvinza and Iragala and in the tributary Ruchugi at Uvinza. This appears to be the first occasion on which fyke nets, which are a European device for the capture of eels, have been tried in African rivers. They are essentially a trapping device operating on the non-return valve principle. Two types of net were used; one with five hoops and one central leader, the other with six hoops and two lateral leaders. The most effective method of setting was discovered to be with the mouth of the net facing downstream and better results were usually obtained in backwaters or small embayments rather than in the full force of the current. Catches varied from ten pounds to forty pounds fish per net/per night and were always heavier with the six hoop, two leader net. The catch consisted predominantly of various

species of Mormyridae (Elephant Snout Fish)—good edible fish in excellent condition (fyke nets retain the fish alive). On several occasions Electric Catfish (*Malapterurus electricus*), including some very large specimens, entered the nets to feed on other fish already trapped. The Electric Catfish, whilst it must be handled with care, is itself an excellent edible fish. Fyke nets have considerable possibilities for use by riverine peoples as they are easy to operate (in many instances they can be set from the shore without the use of canoes) and are relatively cheap (ca. Shillings fifty to sixty). Further data are required on the length of life of one net in relation to the value of fish caught in it and on its liability to damage by crocodiles or hippos.

Lake Rukwa

The Lake Rukwa fisheries which lie in the Chunya and Mbeya districts of the south basin of the lake, and which had been closed by drought since October, 1949, were reopened to fishing on February 1st. They operate under the ægis of the Lake Rukwa Fisheries Board of which the Fisheries Officer (Inland) is the Technical Adviser. Fishing is permitted by one European licensee who is also required to purchase, process and market the catch of the native fishermen.

The licensee handled 1,025,510 "ngege" (*Tilapia rukwaensis*), approximately equivalent to 300 tons fresh fish of an estimated retail value of £10,000 and 48,168 lb. (fresh weight) of "kambale" (*Clarias mossambicus*) valued at £450. Monthly returns are given at Appendix B. It should be noted that these reflect fluctuations in fishing effort rather than in availability of fish.

The Fisheries Officer spent the month of February in advising and assisting both the licensee and the native fishermen in restarting the fishery. The physical difficulties to seine netting presented by the encircling barrier of vegetation which had been forecast in previous reports, were only too apparent and had not been entirely overcome by the end of the year. The decay into which native canoes and gear had fallen during the closure also led to a slow start, but with an assured market at good prices the native fishery soon got into its stride and has made most encouraging progress. So many of the local natives were fishing on their own account that the licensee was suffering from an acute shortage of labour at the latter end of the year and had to reduce his own fishing effort accordingly. By December he had no nets of his own fishing and was entirely engaged in collecting, processing and marketing the native catch. The local natives (mainly Wabungu) are peasant-fishermen and there was a drop in their fishing effort during the cultivation season at the year's end. In the 1949 drought, famine at the lakeshore was aggravated by the fact that many of the Wabungu had neglected cultivation for the more lucrative pursuit of fishing and Government has insisted that this should not recur.

Purchases of "kambale" or Catfish (*Clarias mossambicus*) from native fishermen ceased at the end of September due to the difficulties of curing and marketing them which were aggravated by the licensee's shortage of labour. The kambale catch is now being cured by the native fishermen for their own consumption and this should lead to a greater quantity of native-caught *Tilapia* being released for processing by the licensee.

When the fishery reopened the licensee attempted regular supplies of fresh fish to Chunya and Mbeya. The difficulty in accumulating sufficient stocks in fresh condition at the lakeshore without refrigeration, and the high cost of transport to Mbeya, rendered this project uneconomic, and, with the exception of a small supply to Chunya, it had to be abandoned. The bulk of the catch was hot-smoked for native consumption and was mainly sold to employers of labour.

Although the crocodile stocks of Rukwa had been so reduced by the hide industry that hunting them had no longer become economic, sufficient crocodiles remain to be a nuisance to fishing. The Fisheries Officer lost a fleet of gill nets to crocodiles in February and several have been shot at the cages where stocks of fresh fish are held in the lake.

It is somewhat early to judge the effect of fishing on the *Tilapia* stocks but there are many indications that the size and weight of the individual marketable fish is improving as are also the numbers of fish of nine inches length and over (the permissible size at which *Tilapia* can be landed). So little is known of the factors controlling growth and reproduction of the Rukwa *Tilapia*, factors which, with the fluctuations in the level of this shallow closed lake cannot be considered constant, that it would be rash to assert that the stock has necessarily improved by "thinning out". Nevertheless this is the impression gained. Rukwa may be compared with a fish pond where experience shows that it must be regularly and consistently cropped if the numbers of fish of economic size are not to be sacrificed for the multiplication of the stock by the breeding of a large population of "runts". Fluctuations in the numbers of *Tilapia* of a certain size at Rukwa may be expected, but fishing is likely to be only one of the factors causing this. It should never be forgotten that the 1949 drought inflicted a catastrophe on the *Tilapia* stocks far more severe than could have been induced by the most drastic overfishing. Yet, within two years, these stocks have sufficiently recovered to yield a crop of over a million fish for eleven month's fishing in a relatively small area of the lake.

Appendix A

Monthly Exports of Dried Dagaa from Kigoma

	Territorial destinations by rail		*Belgian ports by lake steamer*
	Tons		
January	66·6	...	33·5
February	84·4	...	69·0
March	149·4	...	38·9
April	34·0	...	42·7
May	15·5	...	3·7
June	10·3	...	3·3
July	74·78	...	—
August	37·49	...	22·5
September	80·15	...	137·0
October	59·45	...	62·62
November	60·43	...	23·58
December	60·21	...	16·3
	732·71	...	453·14
		1,185·85	

Appendix B

Monthly Returns of Fish Handled by the Lake Rukwa Licensee

	Number of "ngege" (Tilapia)		*lbs. of "kambale" (Clarias)*
February	27,732	...	3,797
March	27,800	...	3,052
April	54,273	...	6,843
May	78,539	...	4,820
June	111,311	...	3,633
July	108,481	...	9,169
August	161,006	...	15,414
September	152,818	...	1,540
October	133,358	...	—
November	91,395	...	—
December	78,800	...	—
	1,025,510	...	48,168

G. J. Lockley,
Fisheries Officer (Inland)

MARINE FISHERIES ANNUAL REPORT FOR THE YEAR, 1952

(Note: For the sake of completeness certain reference is made to the end of 1951)

In November, 1951 I drew up a detailed plan for preliminary work of the Marine Fisheries Unit, namely a survey of the native fishing industries. Some preliminary work was done in the Southern and Eastern provinces.

Before I went to the Southern Province I was impressed with the urgency of the need for fish as a protein food; after my return I submitted a note to the Director on the Development of the Sea Fisheries, giving in outline the different requirements of a unit aiming at food production, general practical marine fisheries research, and a survey of the indigenous fisheries, in this I stressed that three vessels would be needed if all three aspects were to be pursued independently.

Change in the Main Object of the Unit

In early December the Department became interested in M.V. *Patoni*, then belonging to Mr. R. B. Bainbridge of Zanzibar, and decided to purchase and fit her as the Department's Motor Fishing Vessel "for the use of the Marine Fisheries Officer in his deep sea investigations off the Tanganyika coast, to provide him with a means for large-scale fishing trials in which deep sea apparatus is used, following favourable reports on the structure and engine by the Harbour Master and the Dockyard Engineers."

Prior to this decision, I had been getting details from firms in the United Kingdom and in South Africa of smaller vessels with shallower draught, suited to coastal survey work.

Application for permission to purchase *Patoni* was made on 28th December, 1951, the vessel was delivered in February, 1952, and was paid for in the following month.

The purchase and refitting of *Patoni* will involve a total capital outlay probably in the region of £12,000.

Hence with the purchase and refitting of a vessel for fishing, and with the appointment of the Master Fisherman, the early completion became desirable of plans for the permanent establishment of the Marine Fisheries Unit, more or less independent, and self-contained in a suitable base.

The present primary purpose of this unit being practical investigation and production, it seemed obvious to me that the fishery should be based on Dar es Salaam, which combines advantages as a base and consumption centre such as nowhere else. A site for the necessary storage and net drying space has been inspected on the Mnarani side of the harbour.

Experimental Fishing

Experimental fishing on any considerable scale awaits the equipping of *Patoni*. Between the time of her purchase and the beginning of October when she was taken up onto the slips for refitting, she was used mainly for trap laying and trolling in nearby waters. Her range was limited, partly because of the absence of water tanks.

While *Patoni* is out of action, fishing activity is largely confined to the area of Dar es Salaam Harbour, and to such operations as can be effected with the use of our small dinghy, or of hired boats. Except for one day when a local businessman kindly lent his motor launch to us and we were able to try out one of our new trawls, we have found it impossible to hire or to borrow any suitable powered vessel for this purpose, although enquiries have been made of the Port Authorities, of the District Commissioner, Mafia, and of various hire firms.

Fishing Gear

(i) *Boubou Traps.*—The boubou trap has the form of a rectangular box: constructed of poles and chicken wire, it has a rectangular funnel-shaped entrance at one end, and works on the principle that it is more difficult to find the nozzle of a funnel than the cup, and depends on the natural curiosity of the fish, bait not normally being used. Dr. Hickling built one of these traps as a model during his visit.

These traps have been used with success in other parts of the world; here results have been extremely variable, but I think experiments are worth continuing.

(ii) *Trolling.*—Trolling was carried out at all times of sailing, streaming usually two or three lines from the stern, and two from improvised tangons. It is proposed to have long tangons fitted for future work. Catches in local waters were variable, but the average was very small. The usual catches were *Caranx* sp., the Kole-kole; *Coryphaena* sp., the Dolphin; and *Scomberomorus* spp., the Kingfish.

Having seen *Patoni* operate with stern lines only over good ground, I know that this method can be profitable.

(iii) *Trawling.*—The trawling equipment arrived from the United Kingdom after *Patoni* had been slipped, and the only experiments on any scale were carried out on Lake Tanganyika on the Inland Fisheries Officer's M.V. *Sangala*, and with the co-operation of Mr. Lockley, who has made out a separate report on the results.

These experiments were useful in showing the limitations of hand hauling and the need for a vessel of sufficient power, apart from indicating the possible value of this method in inland waters.

(iv) *Ring-netting and Seining.*—A large and a small net were made up from locally obtained materials, and used in ringing and in beach-seining operations. The larger net has been tried out in many places and at all hours. Success with this net appears to depend on knowing the location of shoals, catches varying from zero to over 240 of the same species (*Hemirhamphus* sp., the Halfbeak). Fitted with a central cod of plastic gauze, this was found to be an excellent means of catching fry in quantity.

The more effective use of this type of gear was prevented by the lack of a boat larger than our dinghy.

(v) *Long lining.*—Long lining has been tried in the harbour, but in this locality has proved effective only in capturing large eels.

(vi) *Bombing.*—I accompanied Professor J. L. B. Smith on his two bombing excursions on a launch provided for him by the Harbour Authorities during his visit to Dar es Salaam. With careful choice of ground, this seems to be a very effective method of fishing, although very expensive and highly dangerous. As a fishing method it is very rightly proscribed by law.

(vii) *Construction and Instruction.*—The Master Fisherman has been busy in instructing the crew in the art of net-making; a trawl small enough for use with a small boat has been made, and a large and a small hand-seine-ringnet made up and roped out. The Indian Mate has proved to be a particularly apt pupil. The crew has been afforded some experience in the handling and the use of trawls. A number of boubou traps were also made.

Refitting of M.V. "Patoni"

M.V. *Patoni* was taken up onto the slips on October 4th, and a detailed plan was drawn up in consultation with the Senior Marine Engineer. The crew's quarters have been stripped out and refitted with five bunks for the crew, and a small cabin for the mate has been constructed. The hold has been stripped out with a view to building a refrigerated fishroom, the outer wall of which has been completed. About one-third of the hold has been left to accommodate a net store and possibly a diesel generator.

Frames for new tanks have been constructed; the new tanks will give a fuel capacity of 245 gallons, and a water capacity of 214 gallons. It is hoped that it will be possible to increase this figure: the exact size of the tanks will depend on what apparatus is to be fitted in the engine room.

A galley and closet have been built aft of the deck cabin, as a structure separate from the cabin, but under an extension of the same roof. The deck cabin is being refitted to accommodate up to four people, allowing for the Master Fisherman, Engineer, one Passenger, and Fisheries Officer.

The wheel standard is being reversed; the fore part of the deck cabin has been moved forward to form, when the work is complete, a separate wheel house. A winch, gallows, bollards for trawling, and other gear are to be fitted, but there is still a considerable amount of apparatus to be obtained and fitted, including refrigeration plant for which tenders have been submitted, but a contract is yet to be awarded.

Visitors

Dr. C. F. Hickling, Fisheries Adviser to the Secretary of State, visited the Territory twice during February and March. He arrived first at Tanga, where he met Mr. Le Maitre, and Mr. Hitchcock, and visited Mr. Von Prinz's fish-ponds, before proceeding to Korogwe. At Korogwe one of the large ponds was drained and the fish sold to a local sisal estate. A small group of sisal growers visited and inspected the ponds.

Mr. Taylor, Fisheries Officer from Khartoum was with us in Tanga and Korogwe.

Professor J. L. B. Smith, the South African ichthyologist, and Mrs. Smith, twice passed through Dar es Salaam. The first time he unfortunately gave us no warning, and his plans to go bombing had to be cancelled. The second

time he was given permission to use explosives, and provided by the Port Authorities with a motor launch. He went on two bombing excursions, on which I accompanied him, to the areas around Bongoyo Island and the Daphne Reefs.

Arrival

Mr. K. Stather, Master Fisherman, arrived in Dar es Salaam on first appointment at the end of July.

Safaris

Numerous sea trips were made in M.V. *Patoni*, four in native fishing vessels, and one in a borrowed launch, apart from the two excursions with Professor Smith.

In addition to the visits to Tanga and Korogwe mentioned above, the coastal survey was continued with visits to Bagamoyo, Sadani, Pangani, Kunduchi, Kisiju and other villages.

I visited Kigoma for a short time at the end of November to confer with the Inland Fisheries Officer, Mr. Lockley and to see something of his work. Two excursions down the Lake as far as Karago were made in *Sangala* for the purpose of carrying out experimental seine, trammel, and gill-netting.

Later the Master Fisherman and crew also visited Kigoma to carry out experimental trawling with Mr. Lockley.

E. H. O. Martin,
Marine Fisheries Officer

ANNUAL REPORT FOR THE YEAR, 1952
FISHERIES OFFICER (FISH FARMING), KOROGWE

First Half of Year

During the first half of the year, the Fisheries Officer was on long leave in the United Kingdom and in his absence the Fisheries Experimental Station at Korogwe was on a care and maintenance basis. Fortunately no harm accrued and all species were found intact on his return in mid July.

Touring

Whilst on leave and *en route* for return Major R. E. Gould visited by arrangement with the Colonial Office, the territories of Gambia, Gold Coast, Sierra Leone and Nigeria to see fisheries there and consult with local fisheries officers. In Nigeria a tour of 1,000 miles from the coast was made to the N. Nigeria plateau to see the projected 500-acre fish farm at Panyam.

A tour was also made to Sudan, Uganda and Kenya. In the first-named country investigations were made into the possibility of introducing *lates niloticus* (Nile perch) as a predator to control fry growth in the Tanganyika ponds. Arrangements are being made to import this species.

In Uganda the Research Organization was visited and the site of the proposed new breeding station, while in Kenya I was able to compare notes with the Chief Fish Warden, Mr. Copley.

Visit of Dr. C. F. Hickling

The Fisheries Adviser to the Colonial Office in the course of his African tour visited the inland fisheries of Tanganyika in February and March. At Korogwe it was arranged for a production pond to be harvested in his presence. Dr. Hickling made a number of suggestions for new experimental work at Korogwe and these are being put in hand. Among these is a plan to build a four-acre pond, the largest at present being two acres, and he also suggested experiments in harvesting by netting as this experience would be useful in localities where it is not possible or economic with the water supply, to harvest by draining. Visits were also made by Dr. Hickling to fisheries projects in Tabora, Mbeya, Tukuyu, Iringa and Tanga.

Second Half of Year

Korogwe Experimental Station.—The Experimental Station was soon put on an operational basis again, all species having multiplied very considerably in the first half year. Among these was the species *Tilapia melanopleura* and there were now sufficient fry available for experimental work on the species to be undertaken. *Tilapia melanopleura* had been imported from the Belgian Congo by air in the previous year.

Preliminary experiments indicate high possibilities with this species as it is an herbivorous feeder and is thought to be particularly suited for introduction into the pond of the African village economy, as the higher technique of

plankton growth in a pond becomes of lesser importance. *Tilapia melanopleura* feeds on grass, banana leaves, etc., and it is easy for the African to ensure adequate supply of this food as compared with the somewhat intangible plankton. The species is a deep bodied fish with relatively few bones. With abundance of succulent grass available it grows fast; it is also readily distinguishable from other species of *Tilapia* and is very hardy in the fry stage for long distance transport. Crops harvested at Korogwe have also shown fish very uniform in size which is an important asset for marketing. The fry of *Tilapia melanopleura* do not start to eat vegetation until they are about six to seven centimetres long, and in this way the fry may be regarded as complementary and not competitive feeders to the adults, thus obviating to a certain extent stunting by overcrowding common in other species.

Training of Africans.—A training class of eight selected Africans attended at Korogwe for three months in October to December. These men were sent by Native Authorities for training and at the end of the course returned to their districts to be advisers on fishery matters and to inaugurate fishery projects. The trainees showed remarkable interest in their work and there is no question of fisheries being regarded as a "dry" subject. The new rest house was used by the trainees for the first time, and the accommodation not only contributed to their comfort but by living at the Experimental Station they are able to devote more time to their work, and see things happen "out of hours". In the course of his tours the Fisheries Officer was welcomed by a number of African Instructors previously trained at the Station and there was certainly a Korogwe Old Boy spirit among them.

Extension Work.—The Fisheries Officer during the half year has visited seven of the eight provinces in the Territory. Very considerable progress has been made in the Territory in fish farming projects and there is widespread interest in the work and a general desire for further information. Recognizing this, the Department has now appointed a second Fisheries Officer for fish farming at Korogwe. He arrived in Tanganyika in July and when he has acclimatized himself to the African environment and learnt the technique of African fish farming should prove useful in extension work in the provinces.

Provincial Breeding Stations.—In the course of the provincial tours it was constantly borne in mind to endeavour to establish local breeding stations in each province to economize in transport for local distribution and to reduce the heavy demands made on Korogwe for stock. These sub-stations are now in being or under construction and are situated as under:

Eastern Province	Mgeta.
Central Province	Singida and Kondoa.
Southern Province	Mahiwa.
Western Province	Kazima, Mwanhala and Urambo.
Northern Province	Moshi.

In the Southern Province the desirability to investigate fish farming potentialities in the Songea and Tunduru districts was made manifest by the acute shortage of animal protein and the possibility of considerable industrial development. There is abundance of water in the area and it has accordingly been arranged to send the new Fisheries Officer to make a detailed survey of the whole area in conjunction with local administrative and departmental officials.

Among the earlier established projects the ponds at Moshi prison are now on a sound revenue producing basis and the Superintendent has a subsidiary industry in the distribution of fry for local stocking purposes. Additional ponds have also been constructed during the year.

General.—A fisheries exhibit was staged at the Arusha Agricultural Show in October and aroused considerable interest.

The rice-cum-fish experiments which were interrupted by the long leave of the Fisheries Officer have again been started using long term varieties of rice imported from Malaya and two species of *Tilapia.*

The growth rate of *Tilapia melanopleura* in the shallow rice ponds during the care and maintenance period exceeded the growth rate in the deeper ponds and there is some reason for thinking that this phenomenon might be worthy of further investigation.

Culture of bananas and paw paws on the banks of the ponds has been very successful, and contributes to the diet of the staff and labourers.

Enquiries for information have been received from a number of territories and dependencies. During the year visits to Korogwe were made by the Member for Agricultural and Natural Resources, the Acting Director of Agriculture, and Fisheries Officers from the Sudan and Uganda.

R. E. Gould,
Fisheries Officer
(*Fish Farming*), *Korogwe*

SOIL CONSERVATION SERVICE, ANNUAL REPORT, 1952

Introduction

The year 1952 has been a difficult one for the Soil Conservation Service. The sudden death of the Chief Soil Conservation Officer, Mr. D. Thornton, who had built up the Service from its beginning was an unexpected blow. Mr. L. J. S. Littlejohn, after acting in the post for several months, was confirmed in the appointment of Chief Soil Conservation Officer. These changes have inevitably meant that the past year has been a period for consideration of past experience and future policies. The changing over of the financing of the Service from a Colonial Development and Welfare Scheme to incorporation in the normal territorial budget has also meant a pause to consider just how the Service is likely to develop.

Staff

At the end of the year, when a full complement of staff was at work, the organization of the Service was as follows:—

Agricultural Officer, Mr. Carlaw, was attached to the Provincial Agricultural Officer, Iringa, as Agricultural Officer (Soil Conservation), Southern Highlands Province. He had under him Agricultural Assistant, Mr. Faun, stationed at Mbeya and African Agricultural Assistant, Mr. Rugarabamu stationed at Tukuyu.

Agricultural Officer, Mr. Johansen, was attached to the Regional Assistant Director of Agriculture, Morogoro, as Agricultural Officer (Soil Conservation), Central and Eastern Provinces.

Agricultural Officer, Mr. Hunter-Smith, was in charge of Tengeru Experimental and Demonstrational Farm and advised on soil conservation measures in the Northern Province on farms other than those on which our own mechanical units were working.

Superintendent of Agriculture, Mr. Taverner, was in charge of soil conservation work on farms in which our own mechanical units were working. These units were in charge of Soil Conservation Officers, Mr. J. D. Evans and Mr. T. H. Evans. Mr. Taverner was also in charge of all survey work, in which Temporary Soil Conservation Officer, Mr. B. D. Bugden, was being trained.

Agricultural Assistant, Mr. Drew and Foreman Mechanic, Mr. Bate, carried out all maintenance and repair work.

Work of the Soil Conservation Service Mechanical Units

A fleet of thirteen Allis Chalmers H.D.5s with Preco No. 2 terracers was available for carrying out work on repayment for individual farmers and organizations. Three small John Deere dam scoops were also available. The main work undertaken has been the construction of diversion ditches and terrace systems for the protection of arable land, a number of small dams and hafirs have been made, farm and district roads have been realigned to conform with conservation plans, and grading and cambering have been undertaken.

A few odd jobs like construction of fish ponds and levelling of fields have been undertaken during times of the year when it was impossible to work on arable land. The following table gives the total work completed during 1952:—

(i) 1,422 acres were terraced, a total length of 257·6 miles of terraces being constructed.

(ii) 12·9 miles of diversion ditches were constructed.

(iii) 2·5 miles of waterways and one and a half miles of training banks were made.

(iv) Six dams and hafirs of a total capacity of eight million gallons were built.

(v) 62·75 miles of road were graded and cambered.

(vi) Six fish ponds covering approximately one and a half acres were made.

(vii) Fifty acres of field were levelled for playing fields or landing grounds. The total cost to the owners of the various works detailed above was Shs. 174,703/50.

A very large number of mechanical breakdowns, mainly track breakages, resulted in the amount of work completed being considerably less than that which had been programmed. Lack of spares delayed repairs and the total work performed by the mechanical units amounted only to about fifty per cent of what ought to be possible.

Other Mechanical Work

Five Preco No. 1 terracers are available for loan to individual farmers who wish to carry out conservation measures under the guidance of the Service, using their own tractors. These terracers were, at the end of the year, all stationed in the Southern Highlands Province. Up to the end of the year, some 350 acres had been protected with approximately thirty miles of terraces constructed with these terracers. A further area had been surveyed and terraces constructed by farmers using their own implements.

Advisory Work

With the exception of certain work in the Southern Highlands Province, the Soil Conservation Service does not attempt to carry out direct conservation work on native land, such work being carried out by the normal district staff of the Department. Advice is given to the district staff whenever it is requested. Advisory work on European farms is given directly but apart from a few outstanding exceptions, the results of such work are not as yet very apparent. With a few exceptions, farmers are usually very much tied to a one-crop economy and find it difficult to develop a more mixed type of husbandry which would enable many desirable conservation practices to be put into effect.

Experiments and Demonstrations

A series of experiments designed to test and compare different methods of treatment of steep slopes of about twenty-three per cent under arable conditions was laid out at Tengeru in 1949-50. The results of three cropping seasons have been analyzed and reported on. The most striking feature

of the whole series of trials is the very persistent "back terrace effect" which most markedly reduces the yields on constructed bench terraces. Elephant grass barrier hedges behind which bench terraces are forming also have a very depressing effect on crop yields due partly to the actual space taken up and partly to competition with the crop. Both bench terraces and elephant grass barriers have, over the average of three seasons, very markedly reduced yields as compared with flat cultivation with no conservation measures at all.

The most striking feature of the "back terrace effect" which was demonstrated this year was its persistence after a three year's Rhodes grass ley. This ley was sown in 1949 and throughout its period of growth, showed little or no back terrace effect. It was ploughed out and sown to maize in 1952 and the back terrace effect on the maize crop was as marked as it is on a newly-formed terrace.

In experiments on different methods of cultivating a steep (twenty-three per cent) hillside, a type of "matengo pit" system has consistently outyielded all other treatments throughout the three years of cropping. This is all the more remarkable since the pits take up a considerable extent of ground and so reduce the number of plants per unit area.

A continuation of the mulching trial reported on last year confirmed that a surface mulch put on at the time of sowing considerably decreases the yield of maize.

Trials with various grasses and legumes of potential value as pasture or cover crops were continued. Many of the most promising, from the point of view of growth, are, unfortunately, shy seeders or difficult to establish. *Pennesetum salifax* has proved to be one of the most useful grasses for establishment on waterways and diversion ditches. It is very easily rooted from cuttings, establishing itself even on raw exposed subsoil, and spreads rapidly once it gets going. *Dolichos formosus* and *Glycine javanica* are the most promising legumes but practical methods of establishment in farming areas outside Tengeru will have to be studied.

Education

One course for Agricultural Assistants, attended by eight officers, was held over a period of eight weeks in April and May. A shorter course of ten days was held for ten Administrative Officers. Eleven Agricultural Instructors from the Uluguru Land Usage Scheme were given a two months' course and four Instructors from Kasulu attended for a month. Shorter visits to Tengeru were paid by a party of Chiefs and Elders from Singida District, by two parties from the Olmotonyi School for Forest Rangers and by pupils from the K.N.C.U. Coffee School.

An exhibition of models, photographs and films was put on at the Arusha Agricultural Show and was well attended by Africans and Europeans.

L. J. S. Littlejohn,
Chief Soil Conservation Officer

APPENDIX

List of Machinery in Possession of Soil Conservation Service

Tractors:	13	Allis Chalmers H.D.5 Crawlers.
	4	Ferguson (Petrol) Wheeled.
	3	Fordson Major (Voco) Wheeled.
Implements:	5	No. 1 Preco terracers (with A.O. (S.C.), Iringa).
	13	No. 2 Preco terracers.
	2	Earth scoops for Ferguson (1 with A.O. (S.C.), Iringa)
	4	Ferguson terracers (1 with A.O. (S.C.), Iringa).
	4	Ferguson scrapers (1 with A.O. (S.C.), Iringa).
	4	Ferguson arc terracers (1 with A.O. (S.C.), Iringa).
	2	Hillside ploughs, ox-drawn.
	2	Harrows (Ferguson).
	1	Philips 2-furrow reversible disc plough.
	1	John Deere 5-6 disc tractor plough.
	2	Trailers (Ferguson).
	2	Water trailers.
Miscellaneous Plant:	1	Stationary Diesel Engine 5 h.p.
	1	Stationary Engine 7½ h.p.
	1	Boxford 4½ in. lathe.
	1	Lighting Plant 5 kw.
	1	Hydraulic Press.
	1	Arc Welding Plant.
	1	Aerospray compressor.
	1	Electric Bench Grinder.

ANNEXURE

SOIL CONSERVATION SERVICE, ANNUAL REPORT, 1952

Soil Conservation in the Southern Highlands Province

Soil conservation work has made good progress during the year, illustrating the benefit of having specialists on district agricultural work. Preliminary surveys had shown where improvement was most needed and work has concentrated on the non-native farms in Iringa, and on anti-erosion campaigns in the Porotos and in central Rungwe, although other areas were by no means neglected. The Agricultural Officer (Soil Conservation) toured the Province advising and assisting where required and supervised the anti-erosion units in Iringa. The Agricultural Assistant (Soil Conservation) supervised work in Mbeya, Chunya and Rungwe and the African Agricultural Assistant was in charge of the Rungwe work. The work of the Soil Conservation Service is not restricted to anti-erosion measures, but includes other aspects of correct land-usage and maintenance and improvement of fertility.

European farms.—An encouraging feature of the work was the increasing demand on the services of the soil conservation unit, far beyond its ability to fulfil with present staff and equipment. The unit did the necessary surveys and provided the graders and operators, while the farmers provided the tractors. 189,544 yards of banks and ditches were surveyed, protecting 1,134 acres on seventeen farms. Work was hindered because the ground was often too hard, owing to the failure of the short rains, for the Preco graders to work. Most of the Iringa soils lack structure and anti-erosion measures alone will not prevent deterioration. More important is good farming with use of manure, rotations, and fallows. Many visits were paid to advise farmers on soil conservation, dam-making, grasses and general problems of soil productivity.

African areas.—No soil conservation work on the scale of the Central Province can be achieved here because tribal turnouts are not customary, work has to be restricted largely to individual farms and done by the farmer himself. Yet the need for communal effort in many areas is very great, especially in the upland areas which are healthy and where people naturally prefer to live. Much of the fertility of the Southern Highlands is now in the valleys of the Ruaha and Kilombero rivers and in the basins of Lake Nyasa and Rukwa.

Iringa.—In the newly-opened area of Ismani, all shambas were marked out but few people made adequate ridges. This area must be adequately protected or it will rapidly deteriorate. Instructors have marked out contours on the steep slopes where the Hehe ridge is not sufficient to prevent erosion. A start has been made in digging protective ditches between the hill-tops and cultivated land, and attempts are being made to interest the people in elephant-grass growing in order to reduce over-grazing on the hilltops. Malangali, Kiponzelo and Mufindi had a closed season for grass-burning, but this was only partially successful.

Njombe.—The schemes are to a large extent soil-conserving and soil-improving, starting with windbreaks and protection of hilltops for afforestation, and bench-forming terraces on steep cultivated land.

Mbeya.—Work was concentrated on three badly-eroded areas in the Porotos and in Mbozi. In Igali, the problem is one of overcrowding on steep slopes and the problem is a serious one, made more so by the suspicion and obstinacy of the people. In Umbwila, any attempts at soil conservation are meeting with fierce opposition. In north Usafwa some progress has been made in protecting finger-millet fields, closing of steep slopes and reducing gully erosion. In Mbozi, narrow-based contour-banks do not seem to be effective and a system of small planting ridges or tie-ridges with grass-strips is being tried out. Work has also been done on demarcating and protecting water supplies. The soil conservation gangs reported 34,737 plots demarcated and 31,367 actually bunded, though the people undo much of their good work by destroying existing bunds in the following year's cultivation and a method of protecting the bunds by planting grass is being investigated. In Unyiha and Unyamwanga, bunding is done only under continued pressure, but there are signs that some people are beginning to see the advantage of soil conservation. The district Natural Resources team discussed problems affecting soil conservation, notably maintenance of soil-fertility in the Porotos, the Kalijembe re-afforestation scheme, early grass-burning in Unyiha, and closing of steep slopes in Usafwa. A scheme for relieving congestion in the Porotos by encouraging planned settlement in the Usongwe Flats was investigated. Two hundred and eighty-six cases were brought to Native Courts in Mbeya for contravention of soil conservation rules.

Chunya.—A start has been made to deal with erosion problems in the areas round Chunya and Kungutas.

Rungwe.—Work was concentrated on the badly-eroded Tukuyu Central area, starting on the Makete ridge. Work is hampered by the complex system of land-tenure and grazing-control of the Wanyakyusa, their ostracism of co-operating farmers and by their unwillingness to turn out for tribal labour.

However, fairly good progress was made in digging contour banks, diversion ditches and in gully controls.

Miscellaneous.—Soil conservation work has been done in conjunction with the Education Department in school and mission gardens and farms. Courses were given to instructors and teachers. The Veterinary Department has been helped in controlling soil-erosion round their cattle-dips and stock-routes. The Public Works Department has been given advice on erosion-control affecting roads in the Porotos and at Malangali, and the Iringa Township Authority has been assisted in making a diversion ditch to prevent soil-wash in the new African housing area. Advice was given to Tanganyika Wattle Estates, Njombe, on the control of erosion in their wattle plantations.

The Songwe plain between Mbeya and Mbozi has been investigated as a suitable area for development.

In general, the attitude of the African has been one of indifference, with hostility in parts of the Porotos. The authorities and some of the intelligent Africans realize the seriousness of the situation and are co-operative, though they may differ from us regarding ameleorative methods to be adopted. The European farmer has shown an encouraging interest in soil-conservation measures, but is still inclined to think that mechanical stop-washes supply the whole answer, whereas nothing except good farming will do.

Various trials have been carried out during the year. It was found that on pumice soils in Tukuyu farmyard manure gave by far the best results, of manure, bat-guano and green-manure treatments. Treatment trials at Tukuyu using various methods of protecting barrier-banks, barrier-hedges, trash-lines and hand-made bench-terraces have not yet yielded any results.

Many local and introduced grasses and other plants are being tested as suitable erosion-controls in Tukuyu and Iringa. It is too early yet to make any definite recommendations. Experiments have been laid down to test the effect of grass-leys and green-manure on subsequent maize and wheat crops.

(This Annexure was prepared by the Provincial Agricultural Officer, Southern Highlands Province).

FIELD EXPERIMENTS, SOUTHERN HIGHLANDS—ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS) FOR 1952

WHEAT TRIALS

General

With the main emphasis on trying to find suitable varieties for the various altitudes and environments eight variety trials were conducted covering the Mbeya and Iringa districts of the Province. These trials revealed a wealth of information. Fertilizer trials, residual fertilizer trials and cultural trials were also carried out.

The variety trials have been classified into two altitude groups: (a) below 6,300 feet; (b) above 6,300 feet for both the Mbeya and Iringa districts, as it is observed that at about this altitude a distinct change occurs from medium and low altitude wheats, to medium high, and high altitude wheats.

A.—Variety Trials

(i) *Below 6,300 feet*

(1) *Iringa District.*—Three trial centres were selected in this district one at Kilolo (6,200 feet), a second at Sao Hill (6,000 feet) and the third at Dabaga (5,900 feet). The first two were successful but the latter was a failure as a result of diseases and bird damage. In each the rate of seeding was 100 lb. per acre, and they were planted in February with a complete fertilizer correctly placed below the seed. The figures from Dabaga are omitted because they are unreliable.

Variety	*Kilolo* lb./acre	*Sao Hill* lb./acre	*Average* lb./acre
291J1I1	1,790	2,450	2,120
294B2A3	1,550	2,040	1,795
261S10C2D	1,725	—	1,725
44/W/34	1,600	1,830	1,715
Kenya Settler	1,170	1,818	1,494
Reward	1,260	1,680	1,470
360H	—	1,460	1,460
B192Q2AL	1,460	—	1,460
338AA1A2	1,290	1,140	1,215
294M7C0A	—	1,110	1,110
Kenya Governor ...	1,225	670	948

In the Kilolo trial there was no significance between varieties, and varieties yielded between six and nine bags per acre. At Sao Hill the significant difference between totals was 782 lb. per acre at the five per cent level and 1,056 lb. per acre at the one per cent level.

291J1I1 was the best variety at both centres and the yield of twelve and a quarter bags per acre is the highest yet recorded in the Iringa District. The first four varieties, which have yielded well, also blend into quite a good flour. 360H looked a very promising wheat but because it has a long growing period the February planting did not enable it to ripen until long after all other varieties had been harvested.

(ii) *Over 6,300 feet*

Of the two centres selected, Kasanga was at 6,400 feet and just out of the forest reserve and Kalinga at 6,500 feet and just in the forest reserve. Both trials were planted during late February with fertilizer placed correctly below the seed.

Variety	*Kalinga* lb./acre	*Kasanga* lb./acre	*Average* lb./acre
337BE2F2	1,782	1,890	1,836
Regent 975·6	1,330	1,700	1,515
291J1I1	1,298	1,500	1,399
338AAIA2	1,110	1,340	1,225
Kenya Settler	1,060	1,200	1,130
294M7C6A	920	1,080	1,000
294B2A3	1,058	744	901
Kenya ploughman ...	900	750	825
Kenya Governor ...	68	468	268

The significant difference between yields for the Kalinga trial at the five per cent level was 1,012·4 lb. per acre and for the Kasanga trial 973·2 lb. per acre. In both cases 337BE2F2 yielded the best. In the field this wheat grew vigorously and ripened evenly and in every way looked the most suitable variety. Kalinga was not as suitable for wheat as Kasanga, for its high atmospheric humidity caused slow ripening, poor wheat samples and difficulty in threshing. At Kasanga the local Africans were very impressed by the trial and were encouraged to take up wheat growing seriously.

(i) *Below 6,300 feet*

(2) *Mbeya District.*—Wheat was planted at two centres, namely Mbozi (5,300 feet) and Uyole (5,800 feet). The former was planted on moderately fertile land and was given fertilizer placed below the seed. The Uyole trial was planted without fertilizer on rich volcanic soil.

Variety	*Mbozi* lb./acre	*Uyole* lb./acre	*Average* lb./acre
44/W/34	1,677	2,325	2,001
291J1I1	1,430*	2,550	1,990
338AA1A2	1,650	2,250	1,950
350AD9C2	1,100	2,500	1,800
294B2A3	1,294*	2,062	1,678
Reward	1,265	1,950	1,608
341F2D2	1,045*	2,137	1,591
Kenya Settler	935*	1,862	1,399·5
360H	707†	1,300	1,003·5

*denotes toxic effects in one plot.
†denotes toxic effects in both plots.

In the Mbozi trial toxicity from a previous trace element trial caused plant failure on parts of some of the plots and as a direct result there was no statistical significance between varieties. In the Uyole trial the significant difference between yields was 546 lb. per acre at the five per cent level and 736·5 lb. per acre at the one per cent level. The varieties 291J1I1 and 294B2A3 yielded extremely well.

(ii) *Over 6,300 feet*

Only one centre was planted, and this without fertilizer at Njiapanda (7,000 feet) in the Poroto Mountains.

Variety	*Njiapanda*
341F2D2	1,837·5
350AD9C2	1,550
337BE2F2	1,425
294M7C6A	1,250
Regent 975·6	1,175
291J1I1	812·5
Kenya Settler	812·5
338AC2E1	687·5
Kenya Ploughman ...	312·5

There was an enormous significant difference of 1,520 lb. per acre at five per cent, but even so, 341F2D2 out-yielded Kenya Ploughman. The largeness of this significant difference was caused by some mysterious plant failure which has not been completely solved but which was probably caused by the abnormally heavy rains upsetting the uptake of nutrients by waterlogging the soil surface even though the soil is free draining to depth.

CONCLUSION

Over the province as a whole the same varieties seem to be suitable to the same altitudes in the two quite widely-spaced districts of Iringa and Mbeya.

B.—Fertilizer and Residual Fertilizer Trials

(a) *Iringa District.*—Two large fertilizer trials of the design $3\times3\times3$ partially confounded factorial experiments were laid down at the two centres of Sao Hill and Dabaga. Each was planted in February and the fertilizers applied were placed below the seed. The treatments were nitrogen, as sulphate of ammonia, applied at 0, 15 and 21 lb. N_2 per acre; phosphate as double superphosphate at 0, 50, and 75 lb. P_2O_5 per acre; Potash at 0 and 50 lb. K_2O per acre, and Dung at 5 tons per acre.

The Sao Hill trial yielded quite well, but the Dabaga trial was damaged by disease and birds and yielded very badly. Even so, each gave similar statistical responses on analyses. In both cases phosphate at the single level significantly increased yields above control. No further advantage was given by the 75 lb. P_2O_5 per acre. Similarly dung and potash significantly increased yields but nitrogen, although it gave a slight increase did not gain significance. The most economic treatment was given by dung fortified by either nitrogen or phosphate, each at the single level, but not both, in giving a yield of seven bags per acre.

Two residual trials were attempted at Dabaga, but because of disease, and a soil fertility trend across the field, no information was gained.

(b) *Mbeya District.*—A complicated $3\times2\times2\times2$ partially confounded factorial experiment was laid down on Irambo Farm in the Poroto Mountains in which the following treatments were applied (a) sulphate of ammonia at 0·2 cwt. N2 per acre; (b) Double superphosphate at 56 lb. P_2O_5 per acre; (c) muriate of potash at 40 lb. K_2O per acre; (d) lime at 30 cwt. per acre and (e) manure at 5 tons per acre.

The experiment was very successful and in the analysis of variance as in the field an enormously significant response was given by manure, and no combination of fertilizer except K and N combined, raised yields above control plots. With the addition of fertilizer to manure only one treatment raised the yield above manure alone, and in most cases they considerably depressed the yield. Help from the Chemist was sought and although much information was obtained it still remains rather obscure why manure had such a marked response, and yet combinations of fertilizer, if anything, depressed yields. Only the interaction of potash and nitrogen raised yields above control, but they failed to raise the return per acre.

C.—Rate of Seeding

Two experiments were laid down, one at Dabaga (a randomized block) and the other at Sao Hill (a latin square). Each was planted during early February with a dressing of Dutch mixture placed below the seed. The rates of seeding were 80, 100, 120, 140 and 160 lb. per acre. There was no significant difference between treatments showing that no benefit was gained from applying more than 80 lb. or the recognized 100 lb. per acre. There is one small observation to be made here, and that is, this season was an excellent growing season for the wheat and probably in a dry year a higher rate per acre may be required.

D.—Time of Planting

In this experiment six dates of planting, each at ten-day intervals commencing during mid-January and going through to mid-March were incorporated in a randomized block. The results were interesting because the date of 16th February which was the date recommended in German times turned out to be by far the best. The early sowing suffered weed competition, rust and insect attack, whilst the late plantings suffered from insufficient moisture, with germination and growth being very slow and weak. The 16th February sowings germinated and grew well and were not seriously attacked by rust nor set back by weed competition.

Pyrethrum Trials

A summary of the year's work is included under the heading "Field Experiments, Southern Highlands" in Section II of this Report. A full report is available on request.

Tobacco Trials

A summary of the year's work is included under the heading "Igumbiro Tobacco Farm, Southern Highlands" in Section II of this Report.

R. Frank,
Agricultural Officer (Experiments)

REPORT OF THE OFFICER IN CHARGE, GOVERNMENT FOOD FARMS, FOR THE SEASON 1951/52

This report covers the crop season October, 1951 to August, 1952. In July, 1952, it was decided that the Kilangali scheme should be closed down.

A. KILANGALI

The pilot scheme at Kilangali was based on fully mechanized paddy production under irrigation, the aim being to take two crops per annum.

Rainfall

The season was remarkable for the early start of the rains, the heavy total fall and their regular distribution from November to the first week of May. 42·34 inches were recorded in eighty-two days.

As a result mechanized field work suffered much interference and the area planted to the long season crop was curtailed.

Development

A new block of 360 acres was ploughed in November, 1951, but due to uncontrolled flooding only 150 acres were sown in February/March.

A further 200 acres were cleared, and 100 acres of this ploughed in June, 1952. New roads were built and a start made with the construction of a new furrow system. At the time of closing down 660 acres were under the plough or ready for ploughing.

Cropping

1951 Short Rain Rice Crop.—One hundred and seventy-six acres of paddy sown in October, 1951 were completely destroyed by Dioch birds (*Quelea* spp.) which nested in large numbers near the field.

1951 Dry Season Maize.—Thirty acres planted in October produced a negligible crop due to flooding and waterlogging by the heavy November and December rains.

1952 Main Season Rice Crop.—150 acres of 360 acres originally broken in November, 1951, were double ploughed and received two heavy disc-harrowings as weather and land permitted. The chief weeds at that time were *Cyperus* spp. and *Typha* sp.

The land was bunded by ploughs and grader at four-inch vertical intervals, the former wider spacing having led to too deep flooding of the rice and to considerable breaks in the bunds.

Soil conditions and weather delayed planting until 28th February, when bunds still contained patches of wet land which could not be tackled by machines. Any further delay might have meant complete failure to sow with the imminence of the long rains.

A seed rate of seventy-five pounds per acre was used, with a view to suppressing tillering as an aid to more even ripening. The varieties used are shown in Table 1.

There was sufficient moisture to bring away the crop without irrigation, which started three to four weeks after sowing as weeds began to appear. Unevenness of the seedbed led to waterlogged patches where stands were poor, and to high patches which dried out before harvest.

Water was supplied to the bunds until two weeks after it was judged the rice was ten per cent in head. Gates were then sealed and water held a further ten days. The land dried out well when the gates were opened, and carried wheeled combines three weeks after draining.

The crop was harvested by self-propelled combine harvesters with very little holdup. Eight and a half tons of paddy per machine were harvested per day. The bags were only half filled in the combine and left to dry for three or four days before bagging.

Table 1 shows the yields obtained.

TABLE 1

YIELDS IN KGS. OF PADDY—KILANGALI, 1952

Variety	*Approx. acreage*	*No. 1*	*No. 2*	*Total*	*% No. 2*	*Yield per acre kgs.*
Kahogo	140	134,000	1,600	135,600	1·18	969
Ngohe	2	1,116	24	1,140	2·1	570
Borakupata	2	629	71	700	10·3	300
Lingwaya	2	750	150	900	16·7	450

COSTS

A complete cost analysis system was adopted for the season's working.

The direct cost of production of the 150 acres, including depreciation on all machinery and equipment, but excluding overheads and capital expenditure, was Shs. 217/- per acre. Overheads were extremely heavy as the station was staffed for a very considerably larger area than could be developed. Allowing for this it is estimated that overheads would bring the total production cost up to Shs. 350/- to Shs. 400/- per acre. At the new prices a crop of 970 kgs. paddy per acre is worth Shs. 528/- per acre f.o.r. Kilosa.

The direct product cost per acre was made up as follows:—

	Shs.	Cts.
Land preparation	89	40
Seed and drilling	17	80
Irrigation	27	70
Transport to field	15	40
Harvest including winnowing, bagging and transport to railhead	67	70
	218	00

Of the expenditure on irrigation, Shs. 22/60 represented the cost of labour repairing breaks in bunds and around gates, and the wages of an African overseer.

Experimental Work

Herbicides.—Observation plots using the ethylester and the amine and trimethyl amine salts of 2-4: D as post-emergence sprays showed considerable promise. The control of sedges was particularly good, and most dicotyledon weeds were killed. Pre-emergence sprays were not so successful.

Seed Rate Observation Plots.—Seed rate of 65 lb., 100 lb., and 126 lb. per acre showed a reduction of tillering from low to high seed rate, and a steady fall in the number of panicles per plant. In mechanized harvesting uniformity of ripening is very necessary and a reduction in late tillers desirable.

Fertilizer Observation Plots.—There was no yield response to ammonium sulphate drilled with the seed at one hundredweight per acre although the plot receiving fertilizer was more vigorous from the beginning.

Conclusions from the Year's Work

Much useful information was obtained in regard to technique for the mechanized production of rice under irrigation in the Territory, and the results of the 1952 main crop can be considered highly satisfactory.

The lack of certain prerequisites for successful irrigation led to the loss of one area of short term rice due to uncontrollable flooding. Heavy expenditure on bunds and cut off drains would have been essential.

Bunds at four-inch vertical intervals proved entirely satisfactory where accurately laid out and where slopes were of the order of 1: 1,500. Unfortunately the slope was variable and in places bunds were too narrow for efficient use of machinery.

The control of water in the bunds by intelligent use of the gates is essential and required a daily European patrol covering ten miles. The training of suitable Africans as water bailiffs would have been essential.

Kilangali was not sufficiently equipped to obtain really level land, which is an overriding essential for efficient production under irrigation.

Flooding controlled a number of dicotyledon weeds, but certain swamp plants naturally thrived. Herbicide trials showed promise in their control.

Seventy-five pounds per acre was none too high a seed rate and ripening was uneven due to tillering at this rate. Higher seed rates may be desirable.

Judging the time to remove water from the ripening rice posed a problem, as at that time numerous immature heads were present. Drainage was based on judging the stage of ten per cent heading, after which, by African experience, the crop is ready to harvest in forty-five to fifty days. Irrigation water was stopped and the gates sealed fourteen days after ten per cent heading was estimated. Drainage started ten days later and the paddy was considered ready to harvest after a further twenty-one days, i.e. forty-five days from ten per cent heading.

Kahogo proved a reasonably satisfactory variety for mechanization, but it tillers too freely, and breaks over badly when dead ripe.

Borakupata and Lingwaya are quite attractive rices for mechanization, standing well when ripe.

Birds formed the chief pest, but did very little damage to the main crop. Nesting colonies were searched for and destroyed, and a trial of blasting part of a colony after dark was successful.

The performance of the machinery chosen for the scheme was generally satisfactory. Failures were more often due to negligence on the part of African drivers than to weakness in machines.

The period during which paddy is in the best condition for efficient harvesting is limited. To avoid excessive losses due to lodging harvest must start when the paddy still contains twenty-two per cent or more moisture. The grain must therefore be dried before final bagging. On a large scale this would probably require some form of crop drier. A spread of harvest by the use of varieties of different maturity will also allow more efficient use of combine harvesters.

Acknowledgment

Even the limited success of this experiment would have been impossible without the early planning and drive of the Regional Assistant Director of Agriculture, Morogoro, and the hard and conscientious work of all the staff under primitive and pioneering conditions, which during the rains, were decidedly fluid. The stoical acceptance of these conditions by African and European staff was praiseworthy. The loyalty and general hard work of the African staff should be recorded.

Grateful acknowledgment is also given of the close co-operation of the Water Development Department and the Government Chemist.

B. LUPIRO/KIVUKONI

While the Lupiro area had been cropped for two years mechanically, the Kivukoni area was only opened up extensively in October, 1951. In these two areas the paddy is grown on rainfall and the haphazard flooding from run off or river flood.

Lupiro.—Much of this area has been cropped by Africans for many years. The land is generally flat and the soils are sandy or silty clays, overlying a heavy clay with a high water-table. Shallow flooding occurs from a nearby river.

Kivukoni.—This area lies between the bush line and the flood level of the River Kilombero, in the main flood plain of that river, on the south bank. The soils are variable, sandy to silty grey alluvium, overlying a variable subsoil of sand and clay. The land cropped was all virgin.

In order to protect the crop from flooding from the river the whole area is surrounded by a large bund. Provision is made for water to be let into the field and some run-off from above the bush line enters it.

LUPIRO

Rainfall

35·59 inches were recorded from 1st January to 31st July.

Cropping

Land preparation was much hampered by an unavoidable late start with ploughing and periods of heavy rain in November and December. The whole area had to be reploughed immediately prior to seeding, pieces being cultivated and sown as they dried out.

One hundred and eighty acres were drilled between 24th January and 6th February using one 12′ drill. An average seed rate of seventy-eight to eighty-five pounds per acre of Kahogo was used. Germination was good except on the sandier land where there was some damage by drought.

Crop growth was good and weeds only developed seriously during harvest. Shs. 1,391/05 was spent on hand weeding.

Harvest started on 23rd June with one 12′ self-propelled combine and one 5½′ towed combine. The latter was unable to deal satisfactorily with the heavy stand and did not operate after 7th July. The rice was dead ripe. The land was still very wet and slowed down operations due to frequent bogging. Heavy dew prevented work before 10.00 a.m. and after 5.30 p.m. A track combine was used from 18th July and the harvest completed by 24th July. By this time most of the rice was badly laid.

Total yield	128,010 Kilos
Average yield per acre...	711 Kilos

KIVUKONI

No rainfall figures are available.

Cropping

Due to the late arrival of machinery and heavy rains in November, all cultivations were rushed.

Only thirty acres of virgin land under six feet grass could be prepared for seeding by 21st January. Drilling was completed by 23rd January. The land received two ploughings and three disc-harrowings. A seed rate of eighty to eighty-five pounds per acre of Kahogo was used.

Germination was excellent but a period of dry weather checked the young plants. Good rains brought about a good recovery. The stand was much better than at Lupiro. Weeds and grass never appeared and with the exception of a few sedges, no hand weeding was necessary.

Flood water entered the bunds on April 29th and reached a depth of four and a half feet. Due to hippo damage the bund was breached in eight places by 6th May, water rose to five feet and much rice was submerged for five to six days. Only five to six acres however were lost due to this.

The crop was ready to harvest by the third week of June but the land was much too soft for a wheeled combine. The track combine could only cross the river on 8th July and combining started on 10th July. By then fifty per cent of the crop was lodged. Only twenty acres were harvested due to game damage, and due to the condition of soil and crop it took fifty-nine hours.

Total yield	18,016 Kilos
Average yield per acre (20 acres) ...	908 Kilos.

Costs

A full cost analysis system was adopted. The total cost of production, including the salary of the Field Officer in Charge, and all direct production expenditure and over-heads, depreciation, etc., was Shs. 246/44 per acre, of which hand-labour formed only three per cent. At the new prices the average value of the crop on the two farms was Shs. 348/- per acre, while at Kivukoni by itself it was worth Shs. 454/- per acre.

Experimental Work

Ammonium sulphate was used in two observation plots at Lupiro, on sandy soils. One half acre was combine-drilled and another half acre top-dressed eight weeks after drilling, at the rate of one hundredweight per acre. There was a marked response in growth and number of heads per plant and a yield increase of twenty per cent from combine drilling and fifty-three per cent from broadcasting. More precise trials are now required.

Numerous varieties from abroad and within the territory were grown for observation. The most promising were the long-term Kikweta and the short-term Maji ya Kunywa.

Conclusions from the Year's Work

The results of the first large-scale crop at Kivukoni must be considered highly satisfactory.

At Lupiro patches of waterlogging occurred and contour bunds are probably necessary to obtain a more even spread of flood water.

At Kivukoni the large bunds built by hand enclosed 105 acres. 2,050 yards of five-foot bank and 2,260 yards of three and a half-foot bank cost Shs. 97/80 per acre.

The Kilombero flood this season was one of the highest within living memory. The bunds stood the test well but damage by hippopotami caused breaks, which were enlarged by the flow of the flood.

The main difficulty lay in draining the land enclosed and gates will be required if this is to be overcome.

Land levelling is even more important than at Kilangali, as the soils dry out much less freely and any low spot remains impassable to machinery for weeks.

Weeds developed rapidly in June at Lupiro as the land dried out, although at the end of May the crops were very clean. Grasses formed a much larger proportion of the weed flora at Lupiro than at Kilangali.

This was a wet season; the land was flooded for some time and weed development may have been subdued. It is a matter for speculation whether in a dry year even good cultivation will prevent weed development in the growing crop, although good stands of drilled rice will reduce the problem to some extent.

While birds formed no problems, hippopotami and pig damaged a few acres, besides breaking the bunds. Strict control measures are required.

Whereas at Kilangali it was possible to harvest with wheeled combines, the slow drying of the Lupiro and Kivukoni soils necessitates track combines. These are slower and less easy to handle.

Useful knowledge has been obtained and the cropped area is to be doubled in 1953.

N. R. Fuggles-Couchman,
Agricultural Officer

INDIAN SCHOOL OF AGRICULTURE, ANNUAL REPORT, 1952

Staff

Since the resignation of one of the Assistant Masters in August, the teaching staff numbered two, but the staff of the Department's Morogoro Farm gave much assistance with practical instruction.

Students and Courses

The courses held during the year have been as follows:—

(a) Final Term of the First Course—January to April.

(b) First year of Second Course—January to December.

(c) An Extension of the First Course—June to December.

Final Term of First Course.—The First Course which had begun in November, 1950, ended in April, 1952. This Course had originally thirty students; some left during 1951, however, and the number attending the final term was nineteen. This term began with a visit to the Soil Conservation Station at Tengeru (7th to 12th January). The remainder of the term was spent at Morogoro.

The final examination was held on the 21st to 26th April. The main subjects were Crop Husbandry, Animal Husbandry and Agricultural Engineering. Subsidiary subjects were Veterinary Science, Botany, Surveying, Plant Pests and Diseases and Farm Management. There had already been an examination in Soil Conservation.

A certificate was awarded to all the nineteen students taking the examination. The ability of each student in each subject was stated on his certificate so that his proficiency was clearly indicated.

A summary of the work done in this final term is given below (Appendix I).

First Year of Second Course.—The First Year of the Second Course began on 21st January and ended on the 13th December. It consisted of three approximately equal terms. Ten students began this Course, but two have since left. Of the eight students now attending, three are from Tabora, one from Mwanza, one from Dar es Salaam, one from Iringa, with two Kenya students from Mombasa.

The number of students is small; there were vacancies for fifteen students (ten Tanganyika and five Kenya). All those who applied for admission to this Course, were admitted, with the exception of one applicant who was too young.

The average standard of these students is higher than that of the First Course students. They have had better teaching, also, as the staff is now conversant with the subject matter.

A summary of the work done by the Second Course is given in Appendix II.

Extension of the First Course.—The First Course lasted eighteen months; subsequent Courses are for two years. Members of the First Course were therefore given the opportunity of returning to the School to take a six months' course of further studies. These further studies will be incorporated in the normal two-year course.

Two students returned for this extension; one left at the end of August, so that one student (from Mombasa) completed this course.

A summary of the work done is given in Appendix III

Former Students.—It is not entirely clear what former students are doing since they left the school. Six are known to be working on farms, and on sisal, coffee and tea estates. Two are known to be engaged in definitely non-agricultural work. There seems a reluctance on the part of some to give information on this, and it is suspected that perhaps half of the former students are in non-agricultural work.

Third Course.—A Third Course beginning on the 26th January, 1953, has been advertised in the Press. At the end of December, 1952, the number of applicants is only two, one from Tanganyika and one from Kenya.

Buildings and Equipment.—Since the beginning of this year, the School has been well equipped with furniture.

Ceilings were fitted to the two dormitories in January.

A water supply has been fitted in the Laboratory.

A Ferguson tractor was handed over to the School from the Agricultural Department, Morogoro, at the end of 1951, and it has been a great help in practical work. There is a 6-cylinder petrol engine for demonstration purposes.

A small gas welding set is available for practical work and demonstration.

A Surveying Level has been obtained through the Crown Agents, as well as a Chemical Balance and some smaller items of laboratory equipment.

Expenditure and Revenue.—Details of the total expenditure of Shs. 90,643/90 during 1952 are as follows:—

	Shs.	Cts.
Personal Emoluments	34,762	05
Other Charges	48,726	90
Transport and Official Travelling ...	7,154	95

Revenue from School Fees and Messing Charges was Shs. 16,482/60.

T. K. Parry,
Education Officer,
Indian School of Agriculture

APPENDIX I

SUMMARY OF WORK

FINAL TERM OF FIRST COURSE (JANUARY-APRIL 1952)

I.—*Visit to Tengeru (Soil Conservation Station) 7-12 January.*

During this visit the students saw a number of agricultural enterprises, as well as soil conservation machinery and practices.

II.—*Classroom Lessons.*

(1) Physiology of Milking in Dairy Cows.
(2) Dairy Processes and Practices.
(3) Methods of Maintaining Fertility in East Africa.
(4) Grasses and Grassland Management.
(5) Capabilities of Tractors, and the Machinery requirements of various farming systems.
(6) Fruit Trees.
(7) Major Insect Pests and their control.
(8) Farm Management.
(9) Animal Breeding.
(10) Plant Breeding.

III.—*Practical Activities.*

(1) Tractor Ploughing, and mechanical planting of Maize and Sunflower.
(2) Marking out and construction of Bench Terraces on about 10 acres of land.
(3) Preliminary survey of about 500 acres at Kingolwira, preparatory to introducing soil conservation practices.

APPENDIX II

SUMMARY OF WORK

FIRST YEAR OF SECOND COURSE (JAN. TO DEC. 1952)

First Term:

Classroom Lessons:

(1) *Crop Husbandry.*—Growing, harvesting and uses of cereals, legumes, oil bearing crops, cotton, sisal and coffee in East Africa.

(2) *Animal Husbandry.*—Place of livestock in agriculture. Types of stock. Types of food.

(3) *Agricultural Engineering.*—Basic principles of Petrol, Paraffin and Diesel Engines. Implements for ploughing, cultivating, haymaking and harvesting.

(4) *Veterinary Science.*—Simple anatomy of livestock. Brief survey of physiology of main organs.

(5) *Botany.*—Outline of plant morphology. Economic importance of various plant products.

(6) *Soils.*—Mechanical Composition of Soils, soil texture and soil structure (with laboratory demonstrations).

Practical Work:

(1) Work on Vegetable Shamba from time to time.
(2) Lessons in Tractor driving.
(3) Mechanical maize planting.
(4) Grafting Mangoes.
(5) Construction of Hay Sweep for use with tractor.

Visits:

(1) Visit to small sugar estate.
(2) Demonstration of Ferguson tractors and implements at Kingolwira.

Second Term:

Classroom Lessons:

(1) *Crop Husbandry.*—Geography, soils and climate of East Africa, in relation to agriculture.

(2) *Animal Husbandry.*—Care and Management and Feeding of Dairy stock. Production of Beef. Breeds.

(3) *Agricultural Engineering.*—Mowing Machines. Diesel Fuel Pumps and Injectors. Petrol Engines and related component parts. Building in concrete, brick and stone.

(4) *Veterinary Science.*—Digestive, Circulatory, Respiratory, Urinary and Reproductive systems of ruminants. These systems in Pigs and Poultry.

(5) *Botany.*—Structure and germination of seeds. Structure and function of roots, stems and leaves. Laboratory experiments in Plant Physiology.

Practical Work:

(1) Hay-making on about twenty acres of land.

(2) Maize silage.

(3) Examination of Ferguson and Albion grass mowers.

(4) Stripping and re-assembling of Ferguson engine.

(5) Malking concrete building blocks and building foundation wall of small store.

Visits:

(1) Visit to Mgeta and surrounding area of Uluguru Mountains.

Third Term:

(1) *Animal Husbandry.*—Care, Feeding and Management of Pigs and Poultry. Incubators and Brooders, care feeding and management of sheep.

(2) *Agricultural Engineering.*—Types of metals used. Clutches and gearboxes. Tracklaying Tractors. Ploughs and cultivators. Seed drills. Combine Harvesters. Mills. Cotton Gins. Milking Machines.

(3) *Veterinary Science.*—Treatment of External Injuries. Choking. Dehorning. Castration. Introduction to study of Parasites.

(4) *Botany.*—Types of flowers and fertilization. Budding, Grafting, Layering, etc. Plant Physiology.

(5) *Grasses.*—Introduction to grasses and grassland management.

(6) *Entomology.*—Introduction to insect pests.

(7) *Soils.*—Top-soil and Sub-soil. Effect of temperature and rainfall on soils. Soil reaction. Soil, Air and Water. The purposes and effect of cultivations on the soil.

Practical Work:

(1) Budding and grafting on mangoes.

(2) Chain and Plane table surveying.

(3) Brake, clutch and other adjustments on Ferguson tractor.

(4) Decarbonising Lister Diesel engine.

(5) Examination of self-lift mechanism on disc plough.

(6) Building small store with concrete blocks.

Visits:

(1) Kingolwira (dairy equipment).

(2) Farms in Wami district (machinery).

(3) Kingolwira (Combine-Harvester and Seed-drills).

(4) Cotton Ginneries (Mikese and Morogoro).

(5) Sisal Estate.

APPENDIX III

SUMMARY OF WORK

Extension of First Course (June to December 1952)

I.—*Classroom Lessons:*

(1) Farm Management, together with a survey of farms in the District.

(2) Important animal diseases in East Africa.

(3) Types of metal used in agricultural machinery, and their recognition. Oxy-Acetylene welding.

(4) Lubrication of machinery, and types of oil used.

(5) Short course in Agricultural Chemistry.

(a) Milk Analysis.

(b) Soil Analysis.

(c) Food Analysis.

II.—*Visits:*

(1) Survey of several farms and estates in the district.

(2) Veterinary Headquarter, Mpwapwa (11th-16th August).

(3) Beekeeping course, given by Beeswax Officer, Tabora.

ANNUAL REPORT OF THE BEESWAX OFFICER FOR THE YEAR, 1952

Staff

During the year there has been an appreciable increase in the field staff engaged on the improvement of beeswax. Two Europeans, the Assistant Beeswax Officer, Mr. S. W. G. Hubbert and a Junior Agricultural Assistant, Mr. I. B. W. Friend, arrived at Tabora in June for training. Subsequently they were posted, the Assistant Beeswax Officer to Songea and the Junior Agricultural Assistant to Mpanda.

The Junior Service Beekeeping Instructor's post which became vacant last year was filled by Mr. Peter Joseph, who is based on Tabora.

Twenty-two new posts for Subordinate Service Beekeeping Instructors in Southern Province were created. Men were recruited and trained for these new posts as well as to fill the vacancies in the original establishment.

The Native Authorities subscribed handsomely for the provision of additional Beekeeping Instructors in areas not covered by departmental men, raising the strength of Native Authority Beekeeping Instructors from four to forty-one.

In addition twenty-seven Agricultural Instructors were trained in beekeeping extension work.

Touring

During the year the Beeswax Officer travelled some 9,000 miles by road examining beekeeping areas in various parts of the Territory. This included a detailed tour of the northern part of Western Province and part of Lake Province in May, tour of the western areas of the Western Province in June, attendance at the Nzega Show and a tour of Southern Province, accompanied by the Assistant Beeswax Officer, in July. A tour of Mpanda District accompanied by the Junior Agricultural Assistant was undertaken in August. In October Central and Northern provinces were toured and an exhibit staged at Arusha Show.

Agriculture

The *Isoberlinia globiflora* honey flow commenced on 10th April and reached its peak in mid May and ended at the end of May. Severe damage to the blossom was caused by storms in the north-west of Western Province, and in Southern Province. Also many hives were destroyed in these storms. Between the 10th April and 31st May, the scale hive at Talikwa increased in weight sixty-three pounds. The largest increase recorded in any one day was twelve pounds on 15th May.

By July bee activity had dwindled to the absolute minimum and in the middle of the month all colonies examined were found to have stopped breeding. In mid-August however, the *Brachystegia* species, followed by *Combretum* and *Terminalia* species, commenced flowering and brood rearing in the hives

got under way. The early honey flow commenced on 23rd September and ended on the 12th October at Talikwa, resulting in a net gain of twenty-five and a half pounds by scale hive in twenty days. Towards the end of November and in December numerous large swarms were encountered, five of which invaded the new Beekeeping Research Station. The failure of the November and December rains caused distress to the bees. Water supplies in the bush began to dry up and the leaves on the trees began to wilt and flowering ceased.

Pests and Diseases

A pest which has been observed for the first time this year is the Banded Bee Pirate, *Palaris latifrons*. This insect waits near beehives and swoops on passing bees. It stings the captive bee and takes it off to its nest for its larvæ to feed on.

For some time, Langstroth and Modified Dadant hives have been sited out in the bush without any protection other than from ants. It was hoped that the honey badger, *Mellivora capensis sagulata*, would attack them in order that any weaknesses in the construction of that type of hive could be discovered. The body boxes were fastened to the floor boards by four crate staples, as is usual when hives are liable to be moved about. Simple flat roofs were used, non-telescopic, merely held in place by their own weight and the propolis used by the bees. For many months nothing happened and then at last the honey badger attacked. It was with relief that it was seen that all he could do was to remove the seven-eighth-inch by seven-eighth-inch entrance block and to scratch the wood. It apparently did not occur to the animal when he found he could not get in by the entrance, that he could possibly remove the roof.

Beeswax Marketing

The 1951-1952 Beeswax season was about the same as the 1950-1951 season. The early crop was not very large and the main crop, for which there had been high hopes, suffered as a result of the May storms. Bee colonies were very much more plentiful but the crop per hive small.

The export figures for the past eight years are as follows:—

1944	...	...	627 tons.
1945	...	...	792 tons.
1946	...	...	732 tons.
1947	...	...	410 tons.
1948	...	...	905 tons.
1949	...	...	525 tons.
1950	...	...	315 tons.
1951	...	...	673 tons.

Owing to the comparatively low price being offered for beeswax during the collecting season, much of the crop was held until the price improved in November. In January and February the f.o.b. price of beeswax was in the region of £500 per ton. In March it declined to £350, in April to £325 but stiffened in May to £365. In June it relaxed to £345 and to £340 in July. There it remained until October when it rose slightly to £350 per ton f.o.b. Dar es Salaam. November saw a further rise to £365 and in December to £375. The remainder of the main crop reached the coast in November and December.

Adulteration of beeswax has almost entirely ceased. However, a lot of dirty beeswax is still being purchased by the traders, and so long as they are prepared to pay for dirt there is no incentive for the beekeeper to clean his beeswax properly.

In Songea and Manyoni districts, where officers have taken vigorous steps to educate the traders, a very marked improvement has taken place. In other areas, where action by European officers has been slight, the instructors have, on the whole, made a small improvement.

Extension Work

Seven courses of a fortnight's duration were held at Tabora for Instructors and a one week's course on frame hive beekeeping was attended by Europeans, Asians, Goans, and Africans, from various parts of the Territory.

Owing to difficulties over printing, the only leaflet to be published in 1952 was No. 22, "Tumia Bomba la Moshi".

"Beekeeping Observation in Tanganyika 1951/52" was prepared for publication in the *East African Agricultural Journal*. A number of articles on Beekeeping by members of the staff have appeared in various Swahili papers.

The preparation of colour slides for instructional purposes has been started. Two series have been completed, the cleaning of beeswax, photographed at Mondo Market, and transferring bees from native hives to frame hives, taken at Talikwa. In addition a series of pictures of vegetation of value to the bees is being collected.

An exhibit was staged at the Arusha Agricultural Show and contact was made with European beekeepers in Northern Province.

In the field the Beekeeping Instructors have continued to press the improvement of the standard of preparation of beeswax. In addition they have been teaching the value of the preservation of bee colonies and encouraging the making of more beehives.

Buildings

In January work started on building the Beekeeping Research Station. November saw the completion of the main building and water supply. The Beeswax Officer himself built the garage in March.

At the close of the year the Research Station still lacked electricity to run the laboratory and the fence round the Station remains to be constructed.

Research

In addition to the beekeeping observations carried out at Tabora and Talikwa with the assistance of a scale hive, meteorological observations were commenced at Talikwa in conjunction with the scale hive.

The collection of pollen from plants, from the pollen loads of bees and from the combs has continued and the technique of preparing the pollen samples for examination has been perfected. A card index code has been devised to facilitate the identification of pollens found in honey and beeswax.

A number of samples of beeswax have been received from various quarters for testing for adulteration. Although the complete analysis is not yet possible owing to the lack of electric power, it has been possible to carry out the most important tests for the detection of adulteration.

F. G. Smith,
Beeswax Officer